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ABSTRACT

This text for a secondary- or postecondary-level course in grain handling and storage contains ten chapters. Chapter titles are (1) Introduction to Grain Handling and Storage, (2) Elevator Safety, (3) Grain Grading and Seed Identification, (4) Moisture Control, (5) Insect and Rodent Control, (6) Grain Inventory Control, (7) Elevator Maintenance, (8) Grain Shipments, (9) Grain Marketing, and (10) Customer and Public Relations. Each chapter follows this format: chapter objectives, teaching aids, supplemental references, student study guide, study questions, and technical and instructional material. Exercises, questions, and/or problems may be provided in the technical and instructional material. Appendixes include Student Self-Instruction Exercises on the topic of stored grain insects and an Occupational Experience Training Plan for general farm supply and elevator employee. (YLB)

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GRAIN HANDLING AND STORAGE

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DEDICATION

We the co-authors would like to dedicate this text to Don Minnis, who was the author of the first Grain Handling and Storage text of its kind. Don has been instrumental in helping to train elevator employees while being employeed by Far-Mar-Co., and Farmland Industries, Inc. His dedication has left a positive impact on numerous instructors, students and cooperative employees in the mid-west.

COURSE SYLLABUS

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CHAPTER I

INTRODUCTION TO GRAIN HANDLING AND STORAGE

CHAPTER OBJECTIVES

After the completion of this chapter the student should be able to:

1. Describe or explain various kinds of grain storage facilities.
2. List advantages and disadvantages of each type of grain storage.
3. Compute and evaluate cost per bushel comparisons.
4. Identify and label grain flow charts.
5. Design and layout on the farm grain storage facilities.

TEACHING AIDS

1. 35 mm slides of Elevator Facilities.
2. Handout of Elevator Flow Charts.
3. Handout of Elevator Blueprints.
4. Visit three elevators or design a farm storage system.
5. Movies and slides from Butler Manufacturing, Agri-Products Div.

SUPPLEMENTAL REFERENCES

1. "Manning Grain-Feed Handling for Livestock & Cash-Grain Farms." Unloading, Drying, Elevating, Storing, Processing, Extension Agricultural Engineer, Kansas State University, Manhattan, KS 66502.
2. "Structures and Environment Handbook." by Midwest Plan Service, Sept. 1975, 7th Edition, Extension Agricultural Engineer, Kansas State University, Manhattan, KS 66502.
3. Successful Farming Magazines.

STUDENT STUDY GUIDE

The following terms and questions should be answered from the Technical and Instructional Material or Supplemental References.

Elevator -

Screw Conveyor (Auger) -

Drag Conveyor -

Auger -

Bucket Elevator (Leg) -

Annex -

Slide Gates -

Closed Loop System -

Buckets (Cups) -

Head house -

Distributor -

Dump Pit -

Boot Area (Pit) -

Belt-veyor -

Spouting -

Flat Storage -

Commercial Storage -

Truck Scale (Platform) -

Truck Hoist -

Overhead Bins -

Inter-stice (Star) bins -

STUDY QUESTIONS

1. What brought about the beginning of the farm grain storage?

2. List the 8 basic types of farm structures or systems and give the advantages and disadvantages of each.

   1.

   2.

   3.

   4.

   5.

   6.

   7.

   8.

3. Explain this statement - Gravity flow of should be used for wet grain when possible.

4. Why is setting up a grain storage system from scratch like growing a good crop of corn?

5. Why is a semi-circular arrangement of grain bins advantageous?

6. Fully discuss 4 of the steps that you consider to be most important before purchasing a grain storage system.

   1.

   2.

   3.

   4.

7. Which should be the largest inflow augers or return augers? Why?

8. Minimum of _____ inch augers should be going to batch dryers.

9. ______ inch augers should be used between the grain receiving pit and wet holding tanks.

10. When is a top conveyor system advantageous over a leg system? Why?

11. What size augers are recommended for fast load out of grain?

12. Name two common places to store grain? ____________ ____________

13. What determines the profits and return on investment an elevator will receive?

14. ___________ and ___________ are the two largest expense items for commercial grain storage facilities.

15. Explain this statement as it relates to commercial grain storage: "The most expensive is always the cheapest."

16. List three building or construction materials used for commercial storage.

1.
2.
3.

17. Why is concrete perferred for commercial elevators?

18. Explain why a lot of commercial elevators add steel bins for extra storage. (Give at least 3 reasons)

    1.

    2.

    3.

19. Name 4 basic designs or types of facilities in use by commercial grain companies.

    1. 3.

    2. 4.

20. List 3 advantages and 3 disadvantages for each of the four types of structures named in the previous question.

21. What is the most important consideration a commercial elevator must be aware of in selecting a building location.

22. Give the disadvantages of using screw-conveyors or augers in commercial grain storages facilities.

23. Identify and name 9 important components to a bucket elevator.

    1. 4. 7.

    2. 5. 8.

    3. 6. 9.

24. Explain what a "closed loop" grain handling system is:

25. Identify and name 10 areas or locations in a concrete elevator.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

26. Describe the location and function of an elevator annex.

TECHNICAL AND INSTRUCTIONAL MATERIAL

Farm Storage

On the farm grain storage was primarily brought about by the beginning of the futures markets. A shrewd businessman in Chicago told a farmer that if he would store his grain on the farm and deliver it back to him in six months he would guarantee an increase in price received for his grain. The storage of grain on the farm also helped to level out the marketing trend of grain thus lowering the price peaks of grain.

Grain is stored on the farm in several different types of structures. Those vary from an inexpensive lathe cribbing to a elaborate grain handling system. They also include complete drying systems to high moisture storage of grain. The types of structures or systems that will be discussed are as follows (1) Wooden bins, (2) Open type structures, (3) Flat bottom bins, (4) Aeration floor metal bins, (5) Pit bottom metal bins, (6) Upright silos, (7) Bunker silos, (8) Highly automated systems.

Wooden Bins

Wood bins were the first type constructed because wood was so plentiful and easy to use. Bins made of wood are the best for high moisture grains as moisture can escape through the sides of the bins. The wood bin had its problems in controlling insects and rodents. It generally had to be lined with some type of metal in order to prevent leakage from cracks or holes. Wood bins today are generally limited to small feed rooms or temporary storage in extreme emergencies during harvest or other circumstances. The auger to scoop shovel is the only way of getting grain in or out of this bin. An example of this is shown in Figure 1.

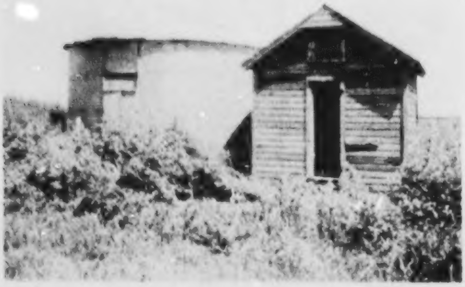


Figure 1

Open Type Structures

The structure can be anything from wooden slated building, rows of picket fencing stacked end on end or metal wire structures filled with corn on the cob. Lath cribbing, wire mesh are used where corn is picked and stored on the cob. This type is generally used in the central corn states. The corn on the cob can be removed from the structures and either be shelled or ground wholly to put into livestock rations. An example of this type of storage is shown in Figure 2.

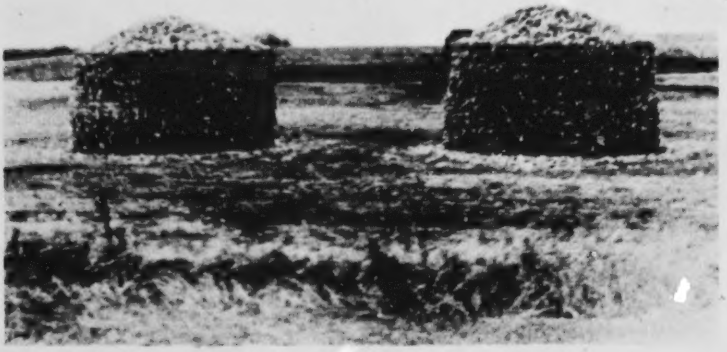
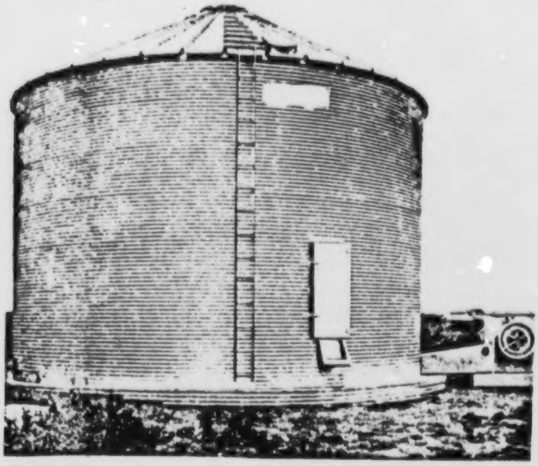


Figure 2

Flat Bottom Metal Bins

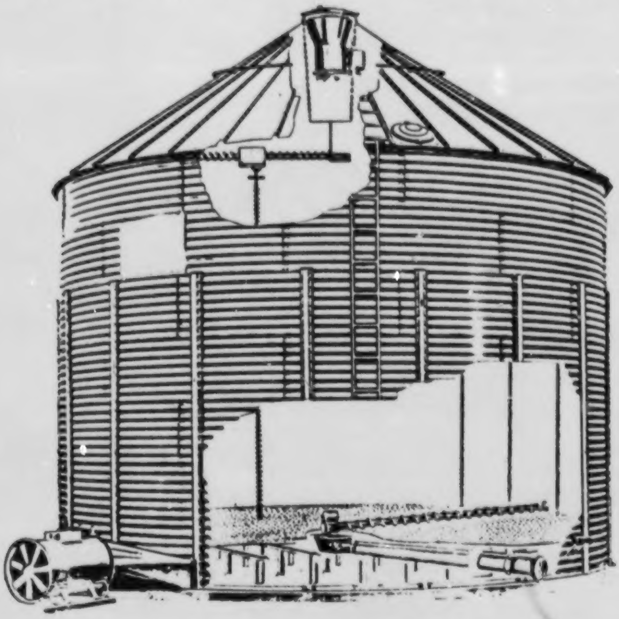
Flat bottom metal bins are probably the most common type of storage found on the farm today because of its ease of placement. They can be put almost anywhere. They don't particularly have to have any special foundation. The foundation must be level and located about surface water. The foundation can be dirt, concrete block, rock or concrete depending on ones desires or finances. The auger to scoop shovel is the only way to get grain in or out of these bins. An example of this is seen in Figure 3.



Flat Bottom Metal Bin
Figure 3

Aeration Floor Metal Bins

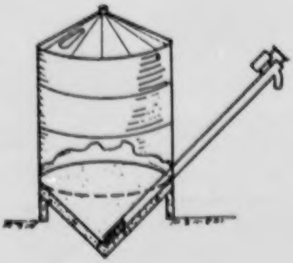
Metal bins do have some variation in them. One can have aeration floor or help control the flow of air through the grain. The use of air with proper timing can either dry grain or cool down hot grain in the winter. Horizontal or portable augers can be used to remove grain from this type of storage. An example of this is seen in Figure 4.



Aeration Floor Metal Bin
Figure 4

Pit Bottom Metal Bins

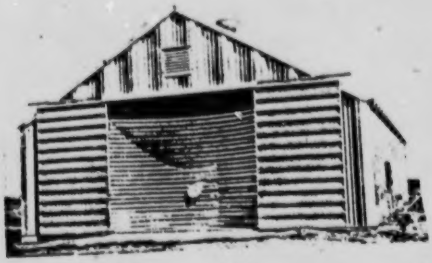
Another variation of the metal bin is putting a funnel shaped pit built in the bottom of the bin. The funnel shaped pit has two advantages over the others previously mentioned. It drastically increases the grain holding capacity and makes it easier in unloading the bin. Grain must definitely be in storable condition when it is put in this type of bin because it has its problems with air movement within the bin. One should not construct one of these types in an area where the water level is near the surface of the ground. An example of this type is shown in Figure 5.



Pit Bottom Metal Bin
Figure 5

Flat Storage

Flat grain storage can include any type of large building, either wood or metal which can be used for the converted storage of grain. This type of storage is generally a cheaper type of storage because of the diversification of the building used. Farm equipment, machinery or livestock can be housed when the grain is removed from the building. This type of storage can be used for either low moisture grain or chemically treated high moisture grain which is going to be fed to livestock. Portable augers are a must when either putting in or removing grain from this structure. An example of this type is shown in Figure 6.



Flat Storage
Figure 6

Upright Silo

Different types of silos can be used for farm grain storage. The most common upright type is the steel air tight glass lined silo. It is used to store high moisture grain which is going to be fed to livestock. Grain is blown in the top and pulled out the bottom with augers. They are used in livestock feeding operations that are electrically punch button operated. An example of this is shown in Figure 7.

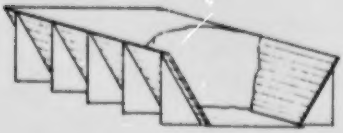
Conventional Upright Silo

Sealed Storage

Upright Silos
Figure 7

Bunker Silo

Bunker type silos are being used to store grain. These bunker silos can either be dug in the side of a hill or made from tilt up concrete slabs sitting on a flat concrete slab. The bunker type silos are primarily used to store ground grain in large livestock feeding operations. Grain removal is generally done with large front end loading equipment because a large amount is needed in a hurry. An example of this type is shown in Figure 8.

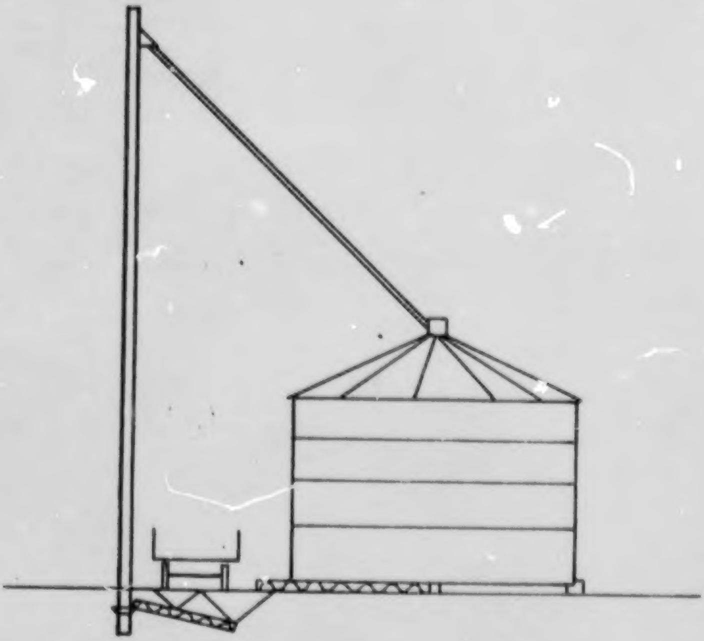


Bunker Silo
Figure 8

Most of the previously mentioned farm grain storage facilities have been independent systems that have required either a large amount of manual labor or portable augers to put the grain in or take it out of the facilities. From here we are going to move into systems that include better designs, more automation and stricter controls.

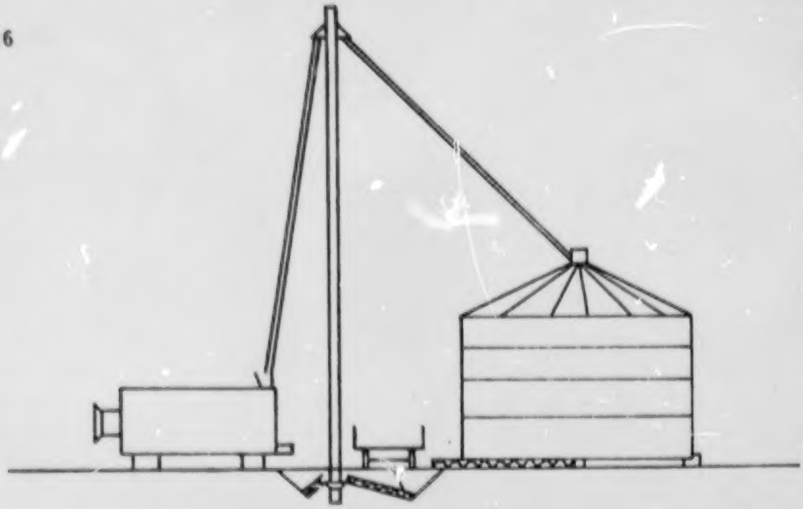
Highly Automated Systems

The ideal grain-flow design develops a closed handline loop through which the grain is stored and processed. Grain is received in the drive-over grain dump, conveyed to the vertical elevator, and dropped by gravity to the bin. The bin is unloaded through an under the floor conveyor, which returns material to the drive-over dump and the loop is then completed. Figure 9 shows this example.



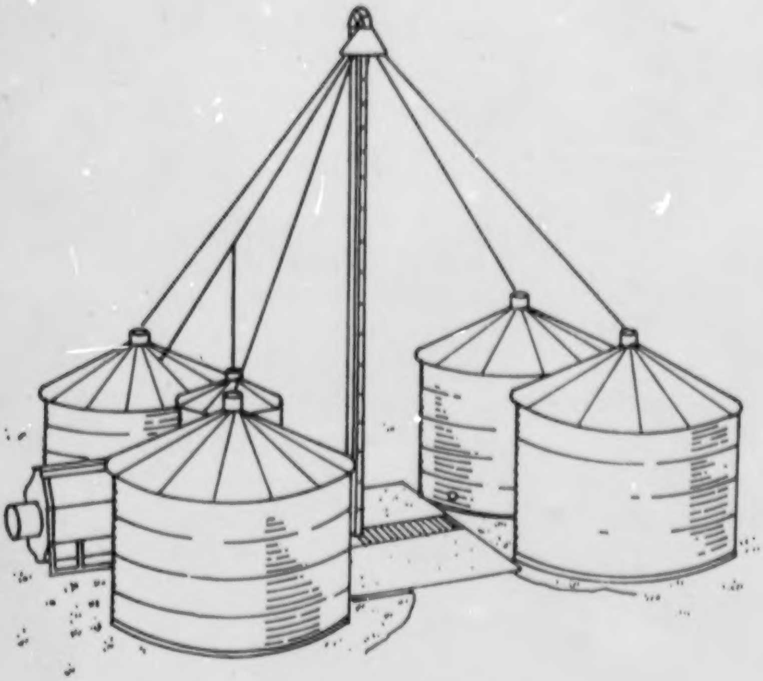
Simple Closed Handling Loop
Figure 9

The grain bin in Fig. 9 could be a bin-dryer without changing the flow. A high-temperature dryer may be added, developing a second handling loop that again returns grain to the starting point. Fig. 10 shows this example.



A Second Loop Through A Dryer
Figure 10

The drive-over grain dump and vertical elevator make the focal point or "center" of the layout; storage bins may be added around this central area. A four-bin layout with space for high-temperature drying may be added as in Fig. 11. The number of bins that can be fitted in the system depends on the space available and the driveway clearance.

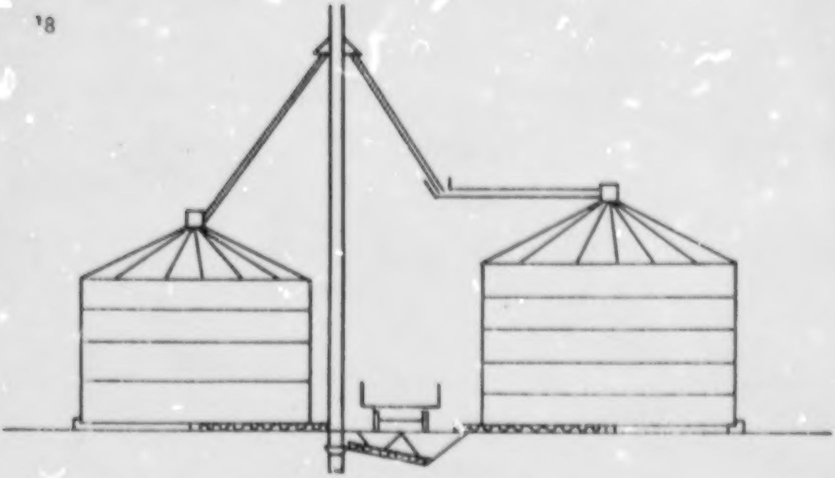


Four-Bin Layout
Figure 11

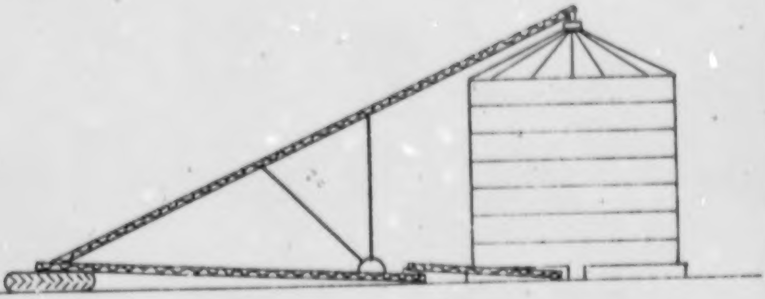
The closed handling loops to this point have used gravity flow from the elevator. There are other ways of filling storages from a vertical elevator.

Gravity flow may be used to one side and on overhead conveyor to the opposite side when bins are located on both sides of the center driveway, dump and vertical elevator. The vertical leg is located as close as possible to the gravity bin to reduce the height of the elevator. Such a layout has a "wet" grain side and a "dry" grain side. Gravity flow should be used for wet grain when possible. Auger conveyors work much better on dry than on wet grain. Increasing the moisture content of corn in 6" augers from 14% to 25% requires four times the horsepower per bushel! Fig. 12 shows this system.

Inclined conveyors can also be used in closed handling loops as seen in Figure 13.

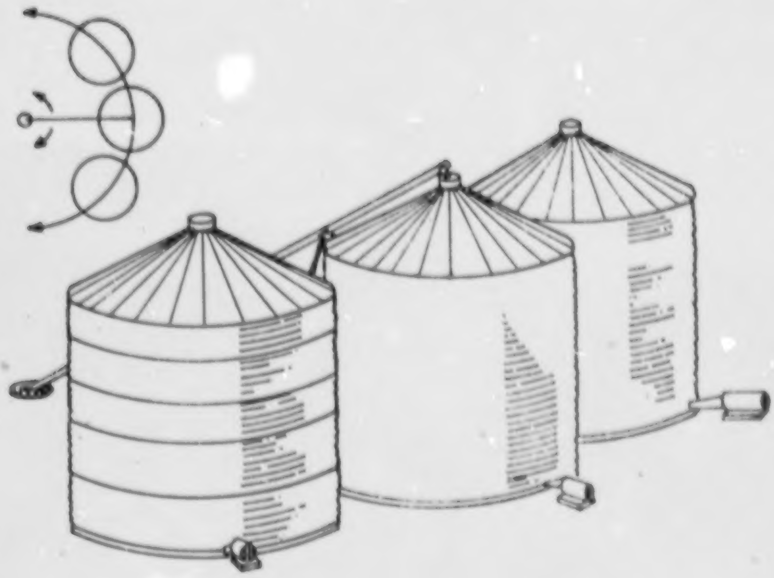


Loop Using Horizontal Conveyors
Figure 12



A Closed Handling Loop With Inclined Conveyor
Figure 13

The inclined (filling) and horizontal (emptying) conveyors must be moved from bin to bin. Bins are usually located in a semicircular pattern. But expansion and future use of a vertical elevator is easier if the bins are in a straight line. Fig. 14.



Inclined (Filling) And Horizontal (Emptying) Conveyors
Figure 14

Flow Principles

Gravity flow is not free in materials handling. You spend money to elevate the material above grade so that it will flow back by gravity. Gravity flow is frequently the most convenient method, but may be highest in cost, and should be applied only where its special characteristics are essential to the process.

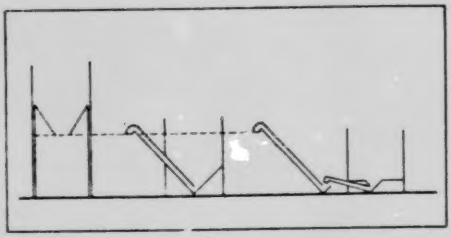
Overhead bins require extra supports. These must be repeated for each bin. Elevated bins also have greater fill heights, requiring taller elevators. In contrast, ground-level bins are lower in fill height, and rest on the ground, which simplifies construction.

A hopper bottom can be installed in a bin to give 100% free flow of material.

A bin-sweep unloader in a flat-bottom bin gives complete unloading, mechanically. The sweep unloader removes material from the floor after gravity flow to the bin center outlet has stopped.

The hopper construction is permanent and must be repeated for each bin. It is costly because of both extra construction and reduced storage capacity. The sweep, in contrast, requires little special construction, wastes no storage volume, and can often be moved from bin to bin. If storages are unloaded in rotation throughout the year and sweep performance is adaptable to the material, cost savings can be sizable.

Three alternative ways of obtaining elevated discharge plus complete bin emptying is shown in Fig. 15.



Three Alternative Ways
Figure 15

Systems Patterns

The flow patterns developed under the discussion of closed-loop handling can be applied to a number of grain-feed handling system layouts. These layouts are based on:

-building one unit at a time--over a period of time, or all at once;

-fitting all types of drying methods;

-containing space for on-farm processing and feed preparation;

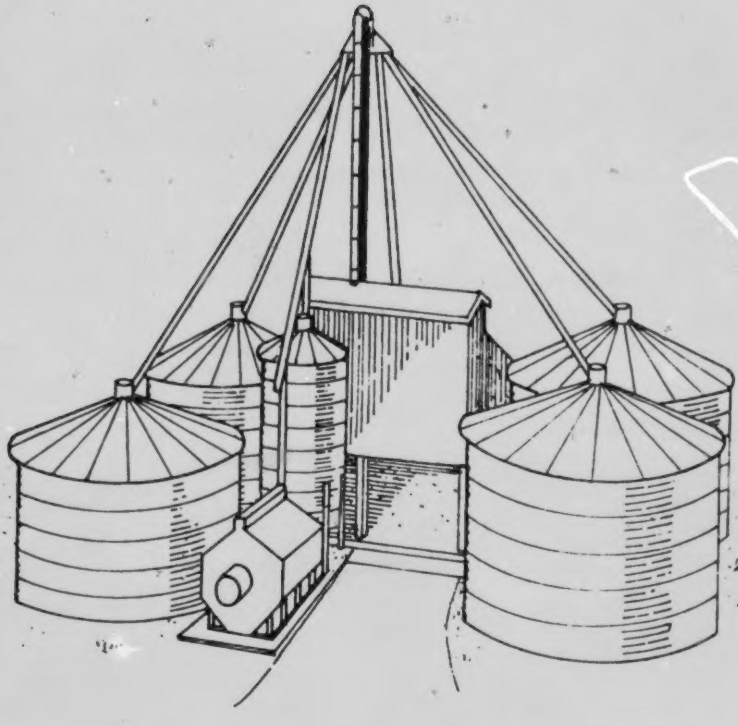
-leaving growth room for alternative handling methods and storage facilities.

A basic pattern is shown in Fig. 16, or an airial view of Fig. 17. It includes a group of bins located about a center building, with the driveway and vertical-elevator grain dump as focal point of the layout. The center building includes a center work tower containing mechanization and overhead hoppered work bins. The building has a single-slope shed roof away from the work tower. This arrangement groups all processing at one end of the building. There is room in the center building for a truck scale. There are two positions for a high-speed dryer. With the grain dump positioned only 4' from the work tower end of the building, trucks can be hoisted outside the building, eliminating need for high inside roof clearance. The dryer position parallel to the drive can be used when space is not available between the bins on the left and can be adapted to an existing row of bins.

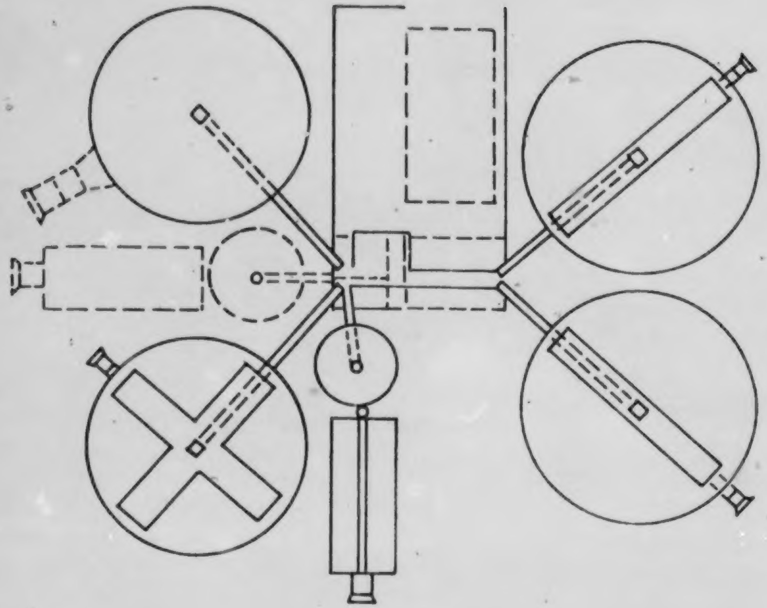
Several shapes of center building are effective. In Fig. 18 the building is a work tower with equal sheds both ways. The elevator and overhead bins are located with work space to both sides.

The bin arrangement and high-temperature dryer poisition of Fig. 18 permits a larger wet-grain holding bin than Fig. 16. It is also a better layout for a continuous-flow drying system with two vertical legs; the second leg is placed between the wet holding bin and the dryer. The divided work area is an advantage in some processing equipment layouts because the overhead bins can directly feed two pieces of equipment, one located on each side of the leg.

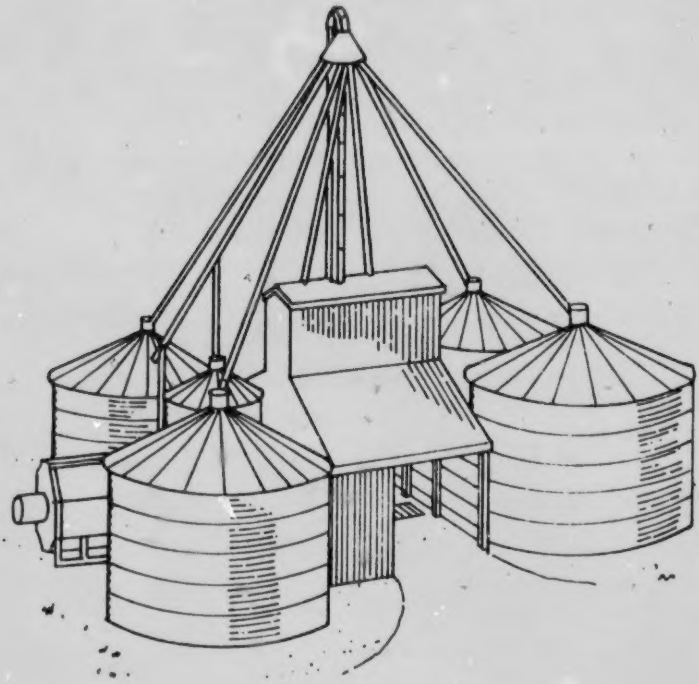
It was mentioned earlier that it is possible to build for inclined elevators now, and still fitl vertical elevators with a center building later.



Basic Flow Pattern
Figure 16

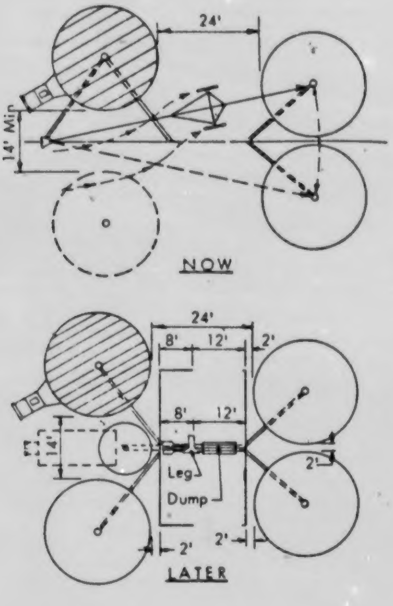


Aerial View
Figure 17



Work Tower Building With Equal Sheds Both Ways
Figure 18

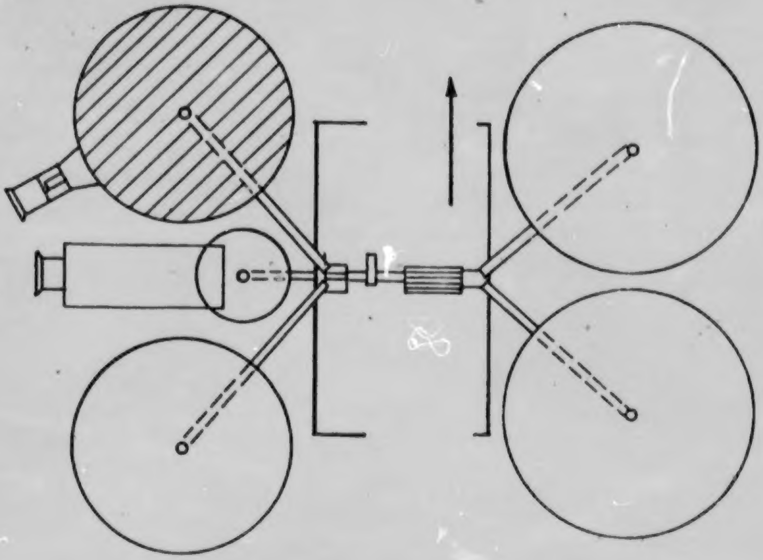
A sample layout is shown in Fig. 19. Notice that the bin arrangement shown is exactly the same as that for the completed facilities shown in Fig. 16 and Fig. 18, featuring the between-the-bins dryer position. The only difference is the use of the inclined elevator, maneuvered through the space for the future high-temperature dryer and center building.



Sample Layout
Figure 19

The same basic concepts and patterns for grain-feed centers can be applied in converting double corn cribs to shelled-corn handling. Fig. 20 shows a crib with a center drive with wide and overhead clearance sufficient for grain receiving and dumping.

Setting up a grain storage system from scratch may be like growing a good crop of corn. Plant in well-prepared soil, fertilize liberally, provide a long growing season to timely maturity and plan for increasing the acreage. Careful storage planning is a must and build on a sound system.



Crib With A Center Drive
Figure 20

A semi-circle arrangement of bins with either work with a pivoting auger or bucket elevator system. Leave the options open to how the economics work out in expanding the system. Leave at least 14 ft. between the grain dryer and storage bins so a grain leg and scale house can be put in if economics is feasible.

Home Storage Planning Format

The following is a list of major steps that should be followed before purchasing a grain storage system.

1. Allow yourself several months to design, price, layout and develop the system best suited to meet your needs.
2. Use every available source of ideas, such as: neighbors with established systems, extension ag engineers and dealers.
3. Have someone draw up a sketch of a possible system. Critically evaluate the system for bottlenecks such as: will it meet future needs, can it be expanded, is it an efficient grain handling operation, is it capable of utilizing automatic handling equipment at a later date.
4. Critically evaluate the physical location of the system. Is it on well-drained ground not subject to flooding? Are power sources nearby? Is there an easy means of getting grain to and from the facility? The noise and dirt and their effect on neighbors should be thoroughly considered.
5. Exchange sketches of the system with some other consultants and try to improve on each new sketch. Double the original grain storage capacity of the facilities to make sure future expansion will work.
6. Once your plans are finalized get at lease two bids. Ask all companies who helped with the planning. Be sure to consult your local dealer. Make sure companies who submit plans don't request commitments or money before submitting a plan.
7. Do not select a price bid because it is cheap. Remember you must work with this system for many years. Select a company that is honest and close enough to help solve any problems you might have.

Design the system for timely speed. It will push an inclined auger system to even reach the capacity of 4,000 bu./hr. leg. The idea here is to have your inflow augers bigger than your return augers. The most pressing need for handling capacity is at harvest. Use a minimum of 8 inch augers to the batch dryer. Use 10-12 inch augers from the grain receiving pit into the wet holding tank. Top conveyor systems over bins are advantageous over 90 ft. or taller leg systems because they reduce grain fall and prevent impact damage.

Keep market channels open. One should have a 10-12 inch high speed loadout auger--to facilitate rapid loadout of harvest time marketed grain. This will take the place of the overhead bin and permit fast loading of forward marketed grain without interfering with the augers that tie up the central driveway.

Economics of Grain Storage

Storing grains following harvest for use or sale at some later date has been a common practice in Kansas for many years. In the last few years, on-farm storage has increased and many questions have been raised as to the economics of storing grain on-the-farm.

Many factors enter into a decision on whether to construct on-farm storage for grains. These can usually be divided into advantages and disadvantages of on-farm storage. Among the more important advantages will be:

1. Storage space will be available at harvest and will avoid bottlenecks when delivering to commercial storage.
2. May be able to store high protein wheat and sell for premium at a later date.
3. Grain will be available for livestock feed on the farm.
4. Will eliminate out of pocket storage fees.

While there seems to be many advantages, there are also some real important disadvantages that should be considered. Among the most important are:

1. The additional investment that is required for on-farm storage may be needed elsewhere in the farm business.
2. Risk of the grain decreasing in value during storage from:
    a. Insect damage
    b. Rodent contamination
    c. Moisture damage
    d. Additional shrinkage
3. Additional labor and expertise will be needed to handle the grain.

1978 U.S. COMMERCIAL GRAIN STORAGE

	Off Farm Commercial* (in thousands of bushels)		Off Farm Commercial* (in thousands of bushels)
Alabama	38,149	Nebraska	487,926
Arizona	34,510	Nevada	
Arkansas	225,901	New Hampshire	
California	161,888	New Jersey	2,239
Colorado	93,158	New Mexico	17,662
Connecticut		New York	72,059
Delaware	17,870	North Carolina	70,237
Florida	7,853	North Dakota	141,842
Georgia	59,814	Ohio	244,536
Idaho	71,490	Oklahoma	205,009
Illinois	787,234	Oregon	66,320
Indiana	282,960	Pennsylvania	30,055
Iowa	634,994	Rhode Island	
Kansas	830,502	South Carolina	33,765
Kentucky	48,689	South Dakota	85,044
Louisiana	132,953	Tennessee	48,007
Maine	3	Texas	837,775
Maryland	42,208	Utah	17,681
Massachusetts		Vermont	1
Michigan	96,665	Virginia	29,997
Minnesota	367,914	Washington	188,762
Mississippi	72,183	West Virginia	612
Missouri	210,375	Wisconsin	129,664
Montana	54,120	Wyoming	6,331

*Off-farm capacity includes storage for rough rice.

No estimate made for Hawaii, Alaska, or Puerto Rico.

On-farm storage data were gathered by ASCS. Commercial facilities were surveyed jointly by ASCS and USDA's Economics, Statistics and Cooperatives Service.

Commercial Storage

Commercial storage is an elevator or warehouse licensed for grain storage by the proper state or federal agency. Storage facilities may be owned by individuals, corporations or by cooperatives. In all cases they must comply with the required rules and regulations of their state or federal license. Occasionally an elevator will losse its license because of imporper procedures, lack of insurance, inadequate financial statements and poor management. A wise producer will not deliver his grain to such a facility. The obvious possibility is that he may never get paid for his grain or it may deteriorate in quality to a point where it has little value.

Commercial elevators are generally built to provide storage and market grian. This requires considerable capital investments. Two important issues must be considered before making this investment.

First, it is a business venture. A corporation, or private individual has chosen this type of business as a method of making money. It is an investment and they expect a return on their money. They want a profit for their efforts.

Second, a co-op elevator may be a matter of necessity. No other company or individual wants to make the investment but grain storage facilities are needed. Consequently,to have the services of storage and marketing in their community, producers will work together and start a cooperative. This is a joint venture by all producers. They each have a financial investment as well as a place to store and market their grain.

Regardless of the ownership, there are certain cost or expenses incurred to operate a grain storage warehouse or elevator. Some expenses are fixed - they remain the same regardless of the size of the storage structure. Other expenses are variable and will change with the number of bushels handled each year. Frequently expenses are broken down to a cost per bushel to arrive at a comparitive figure. Below is a list of items that are both fixed - cost and variable - cost.

Depreciation
Electricity
Interest on Investment
Interest on Inventory
Fumigation chemicals
Repairs
Freight charges

Taxes
Fuel for Dryer
Labor
Inspection Fees
License and Bond
Shrink
Insurance on Structure
Insurance on Grain

Generally, handling and storing grain is like farming. When it comes to expenses. The more bushels you can handle the smaller your cost per bushel will be. After the initial construction cost are met, the two biggest expense items for commercial elevators are electricity and labor.

GRAIN HANDLING COST AT LOCAL CO-OPS

			Cents Per Bushel	Expenses
Fixed Expenses			Low	High
A.	Depreciation		1¼¢	2¢
B.	Taxes		¼¢	½¢
C.	Insurance		¼¢	½¢
D.	Interest on Investments		¼¢	1½¢
E.	Licenses and Bonds		0¢	1/8¢
Variable Expenses				
A.	Labor		4¢	4½¢
B.	Maintenance and Repairs		1¢	1½¢
C.	Utilities		1¢	1½¢
D.	Shrink		1¢	2¢
E.	Fumigation		½¢	1½¢
F.	Interest on Borrowed Capital		¼¢	3/4¢
G.	Other			
	1) Market Discounts	1¢		
	2) Dockage	½¢		
	3) Inspections & Proteins	¼¢		
	4) Misc. (Truck & Trac. Ex)	¼¢		
	5) First 30 days Storage	1½¢	3/4¢	3½¢
	Total		10.75¢	19.9¢

The efficiency at which an elevator can handle and market grain determines their profits and their return on investment. Improper management and inefficient operations can loose money and loose it very quickly. Consequently, good management in a commercial elevator requires experience as well as wise, intelligent decisions.

Common Design

Cost of the building materials measured against their durability has long been the deciding factor in constructing commercial storage. For commercial storage facilities the most expensive material is generally the cheapest! The reason for this statement is that commercial facilities are built for high volume, through-put, durability, and efficiency of operations. So the most expensive is generally more durable, higher quality, better designed, and constructed of heavier materials. Consequently, they last longer, can handle more bushels and ultimately are the least expensive per bushel for total bushels handled.

Three building and construction materials are used for grain storage facilities. They are wood, steel and concrete. Wood was first used for two reasons. It was plentiful, easy to use and the size of the structure was not very large. Following 1945, storage as well as handling the grain was important, so the size increased. Concrete was durable, inexpensive and became the priminent building material. However, if storage was the only function the structure had to serve, large steel buildings were erected. In 1978 concrete was in short supply and more expensive so steel became the choice building material for grain elevators. Large steel tanks bolted together were erected in large numbers across the grain belt. Concrete was used sparingly due to the cost and long payout period. Also during this time (1978) interest rates were high adding to the total cost of construction eliminating the feasibility of building with concrete.

There are four basic designs or types of facilities in use today.

They are:

(1) Iron (metal) clad wooden frame elevators

(2) Bolted and corrigated steel tanks

(3) Concrete elevators and bins

(4) Flat storage buildings of wood or steel

The advantages and disadvantages of each type of structure is listed below:

Type of Structure

Iron-Clad Wood

Advantages

1. Upright structure
2. Small bins for segregation
3. Excellent for blending
4. Good for handling fragile grain
5. Generally paid for with no debt load
6. Good for diversified multiple grain crops

Disadvantages

1. Generally small in size
2. Old outdated equipment
3. Potential fire hazard
4. Cannot handle large trucks
5. Cannot load out large volume of grain quickly
6. High insurance rates
7. Excessive exterior maintenance is required
8. Expensive to build because of material and labor cost
9. Difficult to adequately fumigate grain

Concrete

Advantages

1. Excellent durability
2. Good high speed handling facilities
3. Good long term storage for maintaining quality
4. Excellent for turning and blending operations
5. Excellent for fumigation
6. Very little structural maintenance required
7. Designed to handle large trucks
8. Can load multiple R.R. cars in one day
9. Generally uses a belt conveying system to move grain
10. Adapts easily to aeration systems

Disadvantages

1. Expensive to build
2. Slower construction because of size, difficulty in obtaining materials and competent contractors
3. Large bins makes it difficult to segregate small volumes, causes wasted space
4. Increased breakage in grain because of height of bins
5. Generally the structure is destroyed if an explosion occurs
6. Lacks versatility - can only be used for grain storage

Flat Storage

Advantages

1. Lowest cost per bushel storage structure
2. Versatility of the structure. Easily adapted to other uses
3. Excellent structure for holding large amounts of grain for long storage periods.
4. Easily adapted to aeration prior to filling with grain.

Disadvantages

1. Difficult to empty
2. Impossible to move grain for fumigation or conditioning.
3. Cannot be used for high volume through-put
4. Labor intensive when removing grain
5. Difficult to adequately fumigate for a complete insect kill.
6. Extended periods of storage will always yield some low quality grain

Cost Comparisons

The first consideration in any commercial grain storage system is transportation. The ultimate function of all elevators is to market grain. Transportation is the largest, most difficult problem to deal with in marketing. Therefore transportation becomes the primary concern when locating and building a facility.

What type of transportation is available. What is the freight charge, what is the likelihood of the cost for freight increasing and what is the possibility of the transportation system staying in existance? All of the questions play a critical role in an elevators long-term existance.

Truckers come and go. Many are financially sound operations. However, there are a few who will be unable to continue operating because of high fuel cost and poor management. Truckers must charge enough to pay their expenses and make reasonable wages. Cut-throat bidding in some areas will run truckers out of business.

Railroads are the primary mover of grain. Their rates are continuing to increase. But more critical than rate increases is the availability of R.R. grain cars for shipping grain. Can an elevator obtain railroad cars when they need them to move grain? If not the rail service is inadequate.

In some parts of the grain belt a serious problem of railroad abandonment exists. Some railroads are finding branch lines unprofitable and in poor repair. Railroad movement has been reduced on these lines and trains slowed down due to derailments. Other trackage has been declared unprofitable and unsafe, so the rail service is abandoned.

The third method of transporting grain is by water. Barges are used on rivers. Ocean going ships load grain for transporting overseas to foreign buyers. For barge traffic to be of any value the elevator must be located on the banks of a navigable river. However, some river transportation is limited to 7 or 8 months of travel because of low water levels or cold water freezing. Grain must be moved by barge when river traffic is favorable.

The best possible situation would be to have access to all three methods of transportation - truck, railroad and barge. The point is, transportation is too critical to ignore when planning, building or buying a commercial elevator.

A second consideration is the design and use of the elevator. Answer the questions, 1. What will be stored? 2. How much will be stored? 3. Is storage necessary? If all that is needed is lifting or elevating capacity it would be foolish to build a large elevator.

On the other hand, if several different grains or commodities will be handled during the same time period large capacity bins are not needed. Instead, a large number of bins should be a greater advantage than a few large capacity bins.

Thirdly, the immediate site location is very important. What is your proximity to producers? Are you located in the middle of town where noise, dirt and truck traffic will be a problem? Is a location available close to highways and a railroad siding? Can a location be found that is served by more than one railroad? What kind of soil is there to build on? Can a concrete elevator be built on your choice of locations or will steel bins have to be used? Soil compaction and density test must be run and the depth of firm soil determined before construction plans can be made.

All of these considerations must be answered before true cost can be analyzed. Below is a table listing the highest , the lowest, and an average cost per bushel for the most frequent types of construction.

	Average	High	Low
Concrete	$3.00	$3.50	$2.75
Steel	1.10	1.20	1.00

Annex of Concrete
$1.50-1.75/bu.

	Average	High	Low
Flat Storage	.65	.75	.60
Wood	6.00	7.00	5.00

Grain Storage Flow Charts

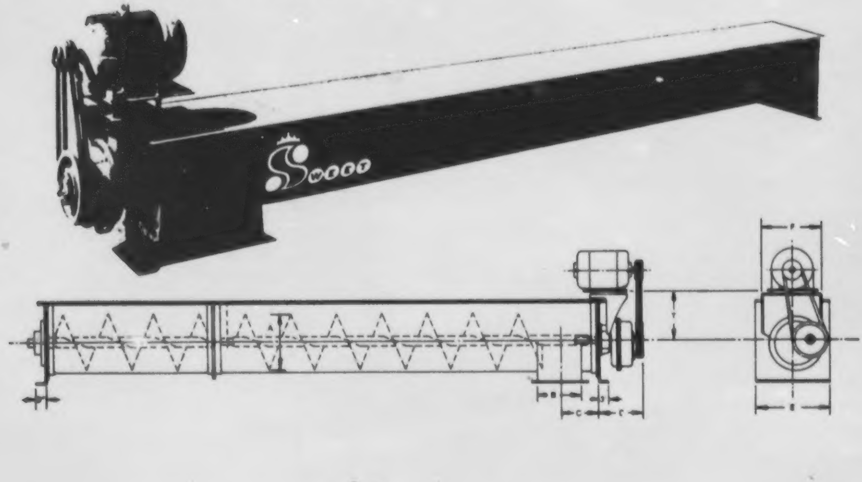
Regardless of the type of elevator or farm storage facilities, they all employ two basic principles for the movement of grain. First, the grain must be mechanically elevated; second, the law of gravity is used. Grain is then elevated to a desired height and dropped into a bin. Some systems must then be used to remove the grain from the bin.

On small scale operation a screw conveyor or auger is the mechanical device used to move grain. A portable grain auger is versatile and can be used for loading and unloading grain bins.

Drag conveyors and portable belt-veyors are sometimes incorporate into a small grain operation. Because of the steep inclines used around bin sides, belt-veyors are not practical. Belts must be staggered or off-set and used at smaller incline angles to elevate grain. On the other hand, belt-veyors are far superior in handling grain because of reduced mechanical damage to the grain. Augers and screw-conveyors cause excessive breakage, crackage, and otherwise damage the grain. It would be safe to say the least expensive and most popular mechanical device used in handling grain is also the most abrasive and damaging to the grain.

When grain capacities increase on the farm vertical bucket elevators are used. Bucket elevators are generally called "legs" as they carry the grain to the top. Vertical bucket elevators are efficient, high speed flat belts with "buckets" or "cups" bolted to the surface of the belt. All commercial storage facilities and many farm storage facilities use this device for elevating grain.

SCREW CONVEYOR

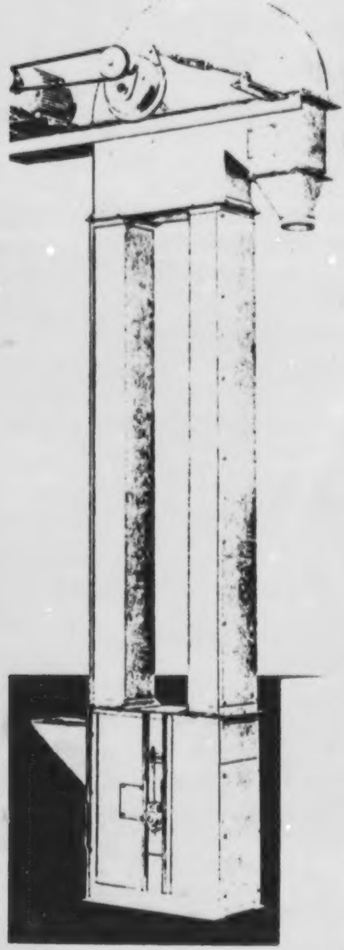


CONVEYORS

TYPE	MATERIALS	CAPACITY	HORSE POWER	OPERATION
Screw Auger	Ground Granular Chopped	Medium	Low to Medium	Some Noise
Belt	Grain Bulk	High	Low	Quiet
Bucket	Ground Granular	Medium to High	Low	Quiet
Chain	Feeds Grain	Medium	Medium	Noisy
Pneumatic	Ground Feed Grain Chopped Forage	Variable	High	Some Noise & Dust

SCREW CONVEYORS
APPROXIMATE CAPACITIES & HORSEPOWER
HANDLING CORN WITH APPROXIMATELY 12" OF FLIGHTING EXPOSED

6" CONVEYOR							
SPEED RPM	MOISTURE CONTENT	ANGLE OR INCLINATION					
		0°		45°		90°	
		BU./HR.	H.P./10FT.	BU./HR.	H.P./10FT.	BU./HR.	H.P./10FT.
200	14%	590	.3	500	.5	275	.4
	25%	370	1.4	200	1.3	155	.4
400	14%	1,080	.6	850	.9	520	.75
	25%	690	1.8	510	1.8	300	.75
600	14%	1,500	.9	1,160	1.3	745	1.1
	25%	950	2.4	680	2.3	380	1.1
8" CONVEYOR							
200	14%	1,050	.5	900	.9	490	.7
	25%	670	3.5	510	2.3	280	.7
400	14%	1,950	1.1	1,530	1.6	940	1.4
	25%	1,250	3.5	930	3.4	550	1.4
600	14%	2,700	1.6	2,100	2.4	1,550	2
	25%	1,700	4.3	1,220	4.2	680	2
10" CONVEYOR							
200	14%	2,000	1	1,700	1.6	930	1.3
	25%	1,250	4.6	950	4.2	525	1.3
400	14%	3,650	2	2,850	3	1,750	2.5
	25%	2,300	6	1,700	6	1,000	2.5



Bucket elevators

DISTRIBUTORS

TOTALLY ENCLOSED

FLATBACK HOUSING

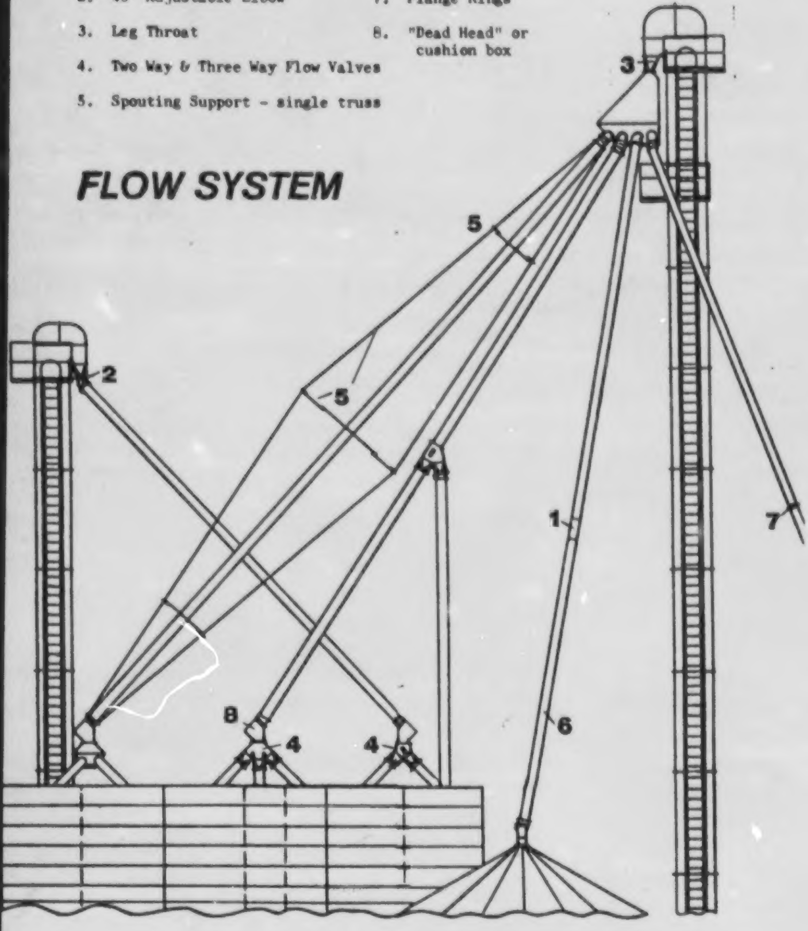
This popular style distributor housing is ideal for use with elevator leg discharges. No special or offset adapters required. Discharges spaced over radius of 180°.

360° HOUSING

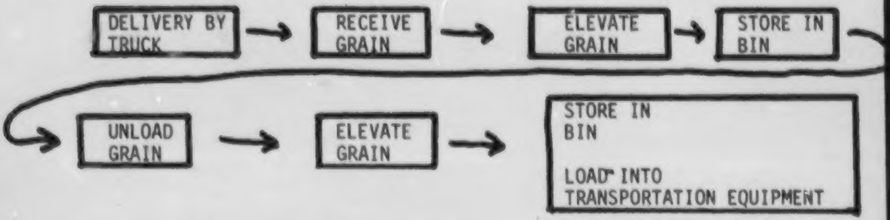
This style housing is often preferred over bin clusters or where distribution to spouts over 180° is needed.

1. Spout Connector
2. 45° Adjustable Elbow
3. Leg Throat
4. Two Way & Three Way Flow Valves
5. Spouting Support - single truss
6. Round Spouting
7. Flange Rings
8. "Dead Head" or cushion box

FLOW SYSTEM



The actual flow of grain through a storage facility follow a repeated lifting, dropping and conveying; lifting, dropping and conveying. A word schematic diagram would appear like the one shown below



This type of design is frequently called a handling loop. With a single bin, auger or bucket elevator and a dump pit the system is called a simple closed loop. A second loop may be added if a grain dryer is incorporated into the system. A multiple loop system including several bins and a grain dryer might also appear.

Farm Materials Flow

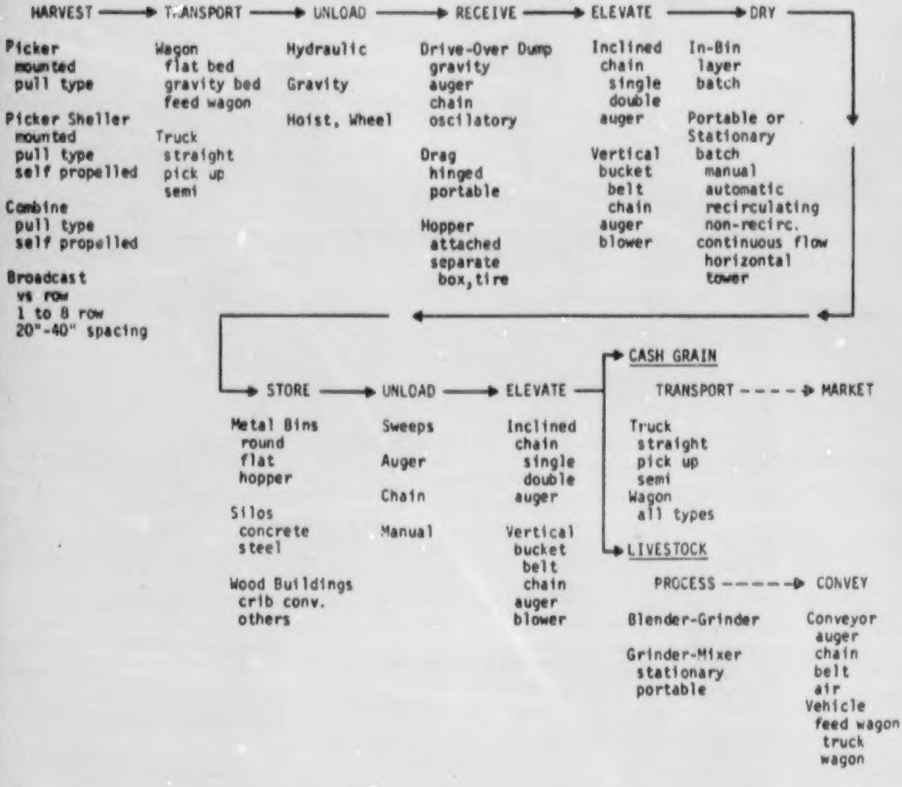
The materials flow process can be divided into its functions to identify some of the critical points and equipment alternatives. The functional sequence in grain harvesting/handling/drying is:

Harvest → Transport → Unload → Receive → Elevate → Dry → Unload
Elevate
→ Transport → Market
→ Process → Convey

The following table will show the flow functions with the equipment alternatives listed below them.

Select one method under each function. Connect them to arrive at a general design for a flow process; there are a number of alternative equipment systems to carry out each of the functions. The problems arise in deciding on the type of system to be used and in selecting component parts that will fit and operate together.

EQUIPMENT ALTERNATIVES FOR EACH FLOW FUNCTION



HARVEST → TRANSPORT → UNLOAD → RECEIVE → ELEVATE → DRY

HARVEST
- Picker
  - mounted
  - pull type
- Picker Sheller
  - mounted
  - pull type
  - self propelled
- Combine
  - pull type
  - self propelled
- Broadcast
  - vs row
  - 1 to 8 row
  - 20"-40" spacing

TRANSPORT
- Wagon
  - flat bed
  - gravity bed
  - feed wagon
- Truck
  - straight
  - pick up
  - semi

UNLOAD
- Hydraulic
- Gravity
- Hoist, Wheel

RECEIVE
- Drive-Over Dump
  - gravity
  - auger
  - chain
  - oscilatory
- Drag
  - hinged
  - portable
- Hopper
  - attached
  - separate
    - box, tire

ELEVATE
- Inclined
  - chain
    - single
    - double
  - auger
- Vertical
  - bucket
    - belt
    - chain
  - auger
  - blower

DRY
- In-Bin
  - layer
  - batch
- Portable or Stationary
  - batch
    - manual
    - automatic
    - recirculating
    - non-recirc.
  - continuous flow
    - horizontal
    - tower

STORE → UNLOAD → ELEVATE → CASH GRAIN / LIVESTOCK

STORE
- Metal Bins
  - round
  - flat
  - hopper
- Silos
  - concrete
  - steel
- Wood Buildings
  - crib conv.
  - others

UNLOAD
- Sweeps
- Auger
- Chain
- Manual

ELEVATE
- Inclined
  - chain
    - single
    - double
  - auger
- Vertical
  - bucket
    - belt
    - chain
  - auger
  - blower

CASH GRAIN

TRANSPORT - - - → MARKET

- Truck
  - straight
  - pick up
  - semi
- Wagon
  - all types

LIVESTOCK

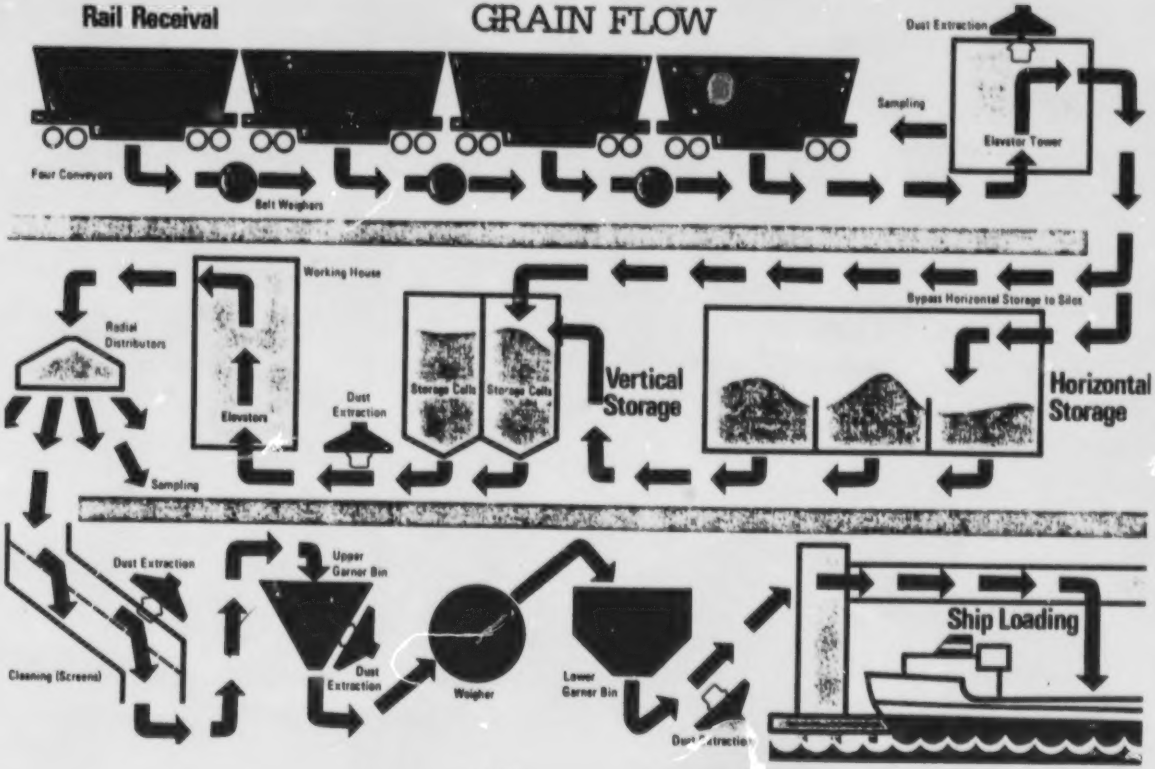
PROCESS - - - → CONVEY

PROCESS
- Blender-Grinder
- Grinder-Mixer
  - stationary
  - portable

CONVEY
- Conveyor
  - auger
  - chain
  - belt
  - air
- Vehicle
  - feed wagon
  - truck
  - wagon

A typical flow chart for a terminal export elevator is shown on the next page. The flow is shown in pictures rather than in words. Note how many times the dust is removed from the grain during the in and out movement or through-put of the grain.

GRAIN FLOW


Rail Receival
Dust Extraction
Sampling
Elevator Tower
Four Conveyors
Belt Weighers
Working House
Bypass Horizontal Storage to Silos
Radial Distributors
Elevators
Dust Extraction
Storage Cells
Storage Cells
Vertical Storage
Horizontal Storage
Sampling
Dust Extraction
Upper Garner Bin
Cleaning (Screens)
Dust Extraction
Weigher
Lower Garner Bin
Dust Extraction
Ship Loading

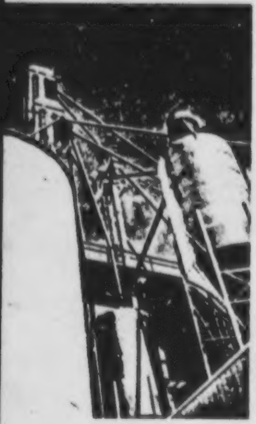
Commercial Materials Flow

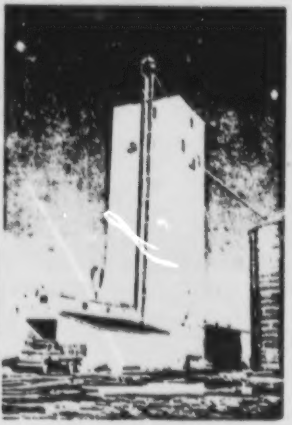
In commercial elevators constructed of concrete, the handling loop system is enclosed and not visible. However, the same flow pattern still exists and can be seen in the blue print designs on the following pages.

After the initial construction of the main elevator or working house, additional storage may be desirable. This additional storage is frequently obtained by building an annex. An annex may be of any capacity.

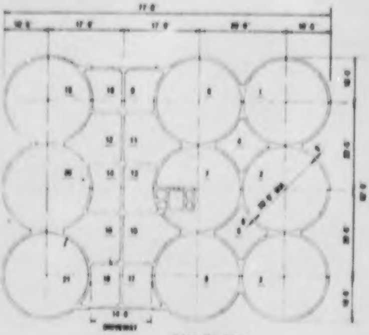
Annexes may be placed at any angle or within any close proximity to the main elevator. Annexes generally are only storage tanks with very little machinery included. A conveying mechanism is used to take grain to the annex and again away from the tanks. Most annexes will use flat belts 42 inches wide to handle this grain movement. However, drag conveyors have been installed on top particulary with open headhouses. (Open headhouses mean the equipment is not enclosed, but all structure but is weather-tight.)

(Review each of the blue prints and determine possible grain flow patterns. Also be able to identify specific parts and locations of a commercial grain storage facility.)





8½ TANK CONCRETE GRAIN ELEVATOR



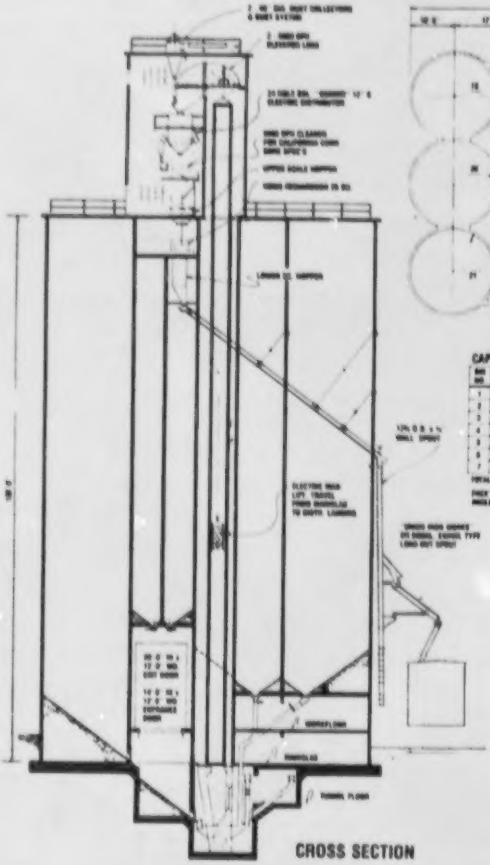
BIN PLAN

CAPACITY CHART @ 128'-0" WALL HEIGHT

BIN NO	BU/FT	BUSHELS STORAGE	BIN NO	BU/FT	BUSHELS STORAGE	BIN NO	BU/FT	BUSHELS CAPACITY
1	251	31,[illegible]	8	251	32,120	15	60	7,[illegible]
2	251	27,[illegible]	9	50	5,070	16	60	7,[illegible]
3	251	31,7[illegible]	10	66	5,570	17	50	5,070
4	61	7,720	11	63	7,870	18	50	5,870
5	61	7,810	12	63	7,070	19	251	30,[illegible]
6	251	31,720	13	56	[illegible]	20	251	32,[illegible]
7	211	23,420	14	56	5,940	21	251	31,[illegible]

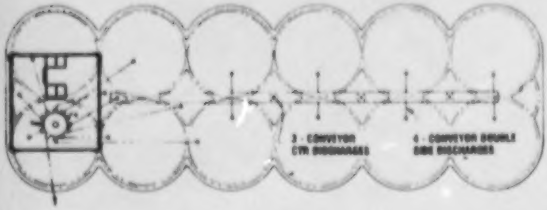
TOTALS 3057 BU. FT 391,270

[illegible]



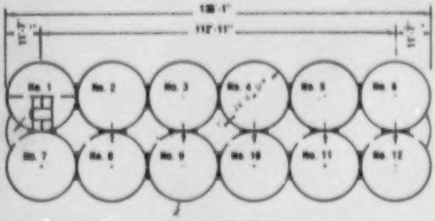
CROSS SECTION

GRAIN STORAGE ANNEX


3 - CONVEYOR
CTR DISCHARGES
4 - CONVEYOR DOUBLE
SIDE DISCHARGES

PLAN @ BIN ROOF

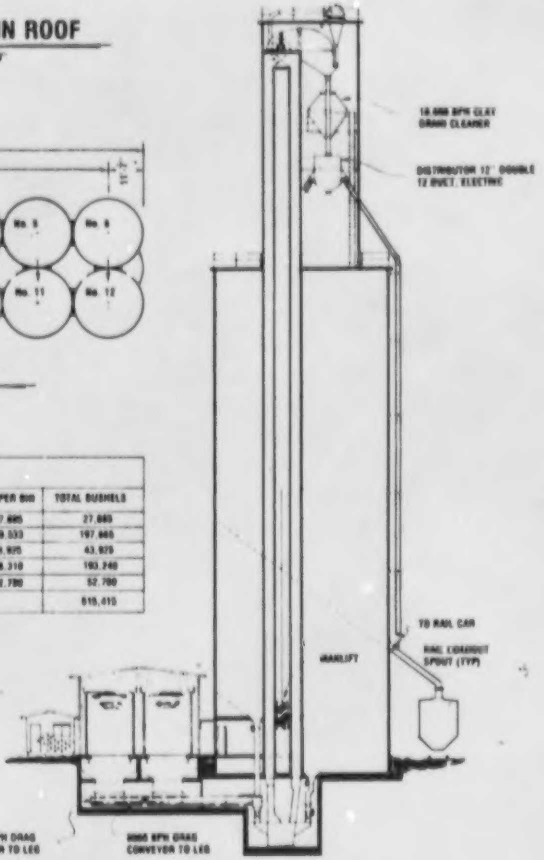
1/16" = 1'-0"


135'-1"
112'-11"
11'-1"
11'-1"
No. 1
No. 2
No. 3
No. 4
No. 5
No. 6
No. 7
No. 8
No. 9
No. 10
No. 11
No. 12

DRAWFORM

1" = 20'

CAPACITY CHART				
BIN NO.	BU. PER FT.	GRAIN HEIGHT	BU. PER BIN	TOTAL BUSHELS
1	242.5	115'	27,885	27,885
2, 3, 4, 5 & 6	304.1	130'	39,533	197,665
7	339.5	130'	43,925	43,925
8, 9, 10 & 11	374.9	130'	48,310	193,240
12	410.3	130'	52,780	52,780
TOTALS				515,415


10,000 BPH CLAY
GRAIN CLEANER
DISTRIBUTOR 12" DOUBLE
12 DUCT, ELECTRIC
TO RAIL CAR
RAIL LOADOUT
SPOUT (TYP)
MANLIFT
12,000 BPH DRAG
CONVEYOR TO LEG
8000 BPH DRAG
CONVEYOR TO LEG

SECTION THRU RECEIVING TUNNEL

1/16" = 1'-0"

CHAPTER II

ELEVATOR SAFETY

CHAPTER OBJECTIVES

After completion of this chapter the student should be able to:

1. Identify hazardous locations in and around an elevator.
2. Point out unsafe conditions and recommend a safer procedure.
3. Demonstrate proper use of safety equipment.
4. Describe the benefits of a good housekeeping program.
5. List precautions and safe practices with grain fumigants.
6. Explain proper grain bin entry procedures.

TEACHING AIDS

I. Films and Equipment
   - A. 35 mm slides - Elevator Safety, Far-Mar-Co., Inc., Hutchinson, KS
   - B. 35 mm slide/tape - Prevention of Grain Dust Explosions, Kansas State University, Dr. Robert Schoeff Grain Science and Industry.
   - C. "The Fire Triangle", National Fire Prevention Association, 16 mm movie.
   - D. Prevention of Fire and Dust Explosions, Extension Publication, Kansas State University, Manhattan, Kansas.
   - E. Fumigant Labels from Current Products.
   - F. Dust Mask and Canisters for Gas Mask.
   - G. Class A, B and C Fire Extinguishers.

II. Student Activities
   - A. Field trip to two or more country elevators.
   - B. Construct and demonstrate a dust explosion chamber.

C. Identify types of fires and fire extinguishers.

D. Demonstrate proper care and use of dust mask, gas mask and self contained breathing units.

E. Demonstrate proper first aid treatment and emergency procedures.

IV. Guest Speakers

A. Local Fire department for instruction and demonstration of fire extinguishers, self contained breathing apparatus, and emergency preparedness.

B. Red Cross Instructor for emergency treatment.

C. Extension personalities to discuss dust explosions and fumigant safety.

D. Industry experts demonstrating and using grain fumigants with proper application and safety procedures.

Supplemental References

1. Practices and Procedures for Grain Department Managers. Farmland Industries Training Center, Kansas City, Mo.

2. "Be Safe When You Use Insecticides" Kansas State University, Manhattan, Kansas, Extension Publication.

3. Phostoxin Training Manual, Phostoxin Company, Alhombra, Calif.

4. Kansas Farm Accident Survey, Extension Publication, Kansas State University, Manhattan, Kansas.

5. First Aid Instructors Manual, American Red Cross.

6. Chemical Applicator License Study Manual, Extension Service, Kansas State University, Manhattan, Kansas.

STUDENT STUDY GUIDE

The following terms and questions should be answered from the Technical and Instructional Material or Supplemental References.

CPR -

OSHA -

ABC's of First Aid -

Shock -

1st degree burn -

2nd degree burn -

3rd degree burn -

Class I chemical -

Class II chemical -

Class III chemical -

Class IV chemical -

Gas mask -

Self-contained breathing apparatus -

Canister -

NIOSH -

Active ingredient -

Label -

Labeling -

Ag chemical -

Insecticide -

Signal words -

Toxic -

General use pesticide -

Restricted use pesticide -

EPA -

Formulation -

STUDY QUESTIONS

1. What percentage of the accidents occuring are the result of faulty equipment or acts of God?

2. What is the major cause of accidents?

3. List 5 different kinds of accidents that can happen around a grain elevator.

   1.

   2.

   3.

   4.

   5.

4. Give one method of preventing each of the accidents you listed in question 3.

   1.

   2.

   3.

   4.

   5.

5. Name the 4 classes of fires and give an example of each.

   1. - Example

   2. - Example

   3. - Example

   4. - Example

6. Explain why "NO SMOKING" signs are placed in grain elevators.

7. What do the letters CPR stand for?

8. Give the first aid treatment for exhaustion and for heat stroke.

9. Name 4 early warning signs or symptoms of fumigant poisoning.

   1.

   2.

   3.

   4.

10. List the equipment needed and precautions taken prior to bin enty for cleaning purposes.

11. What equipment is used most in a good housekeeping and cleaning program.

12. How many men can safely ride the man lift at one time? (Why?)

13. Where do most grain dust explosions occur in the elevator? (Give a location)

14. Explain the checks and operating procedures for the truck hoist.

15. Give the classification and grouping for electrical motors and switches used in elevators.

16. Give the color and type of canister needed for phostoxin, 80-20, and chloropicrin.

TECHNICAL AND INSTRUCTIONAL MATERIAL

Introduction to Safety

Working around grain bins and elevators is generally classified as hazardous work areas. This classification is a result of carelessness on our part when it comes to safety. It certainly is true that accidents are caused, they do not just happen! People get relaxed in their safety efforts, their work habits and their attitudes. It has been said many times - people are the weakest link in any safety chain.

Insurance companies now report that 85% of all accidents are the direct result of human error. That says that people, you and I, are responsible for accidents that occur. Only 10% of the accidents during any given period can be attributed to faulty equipment, with 5% classified as acts of God.

As employees of elevators we must stay alert and continually watch for problem areas. We must use our good judgement and common sense rather than taking short cuts and neglecting potential problems. Whenever safety is first we have the good judgement to eliminate accidents. We respect danger and avoid making errors. In elevators the stakes are high. Frequently an accident may cost you your life. There may not be a second chance.

First Aid (Have a Certified Red Cross Instructor Teach First Aid.)

By law every place of employment must maintain a first aid kit and have at least one person on every shift trained in emergency procedures. Around an elevator a number of circumstances may arise which requires first aid. Everyone should know how to administer first aid in any of the following situations.

1. Treatment of shock and heat stroke.
2. Poisoning or asphixation
3. Head injuries or unconscientiousness
4. Cardio-Pulmonary Recesitation (CPR)

Routine instruction and practice covering first aid procedures should be included in everyones safety program. Practice and training make emergency plans work.

In addition to first aid training, emergency procedures and emergency telephone numbers must be known. Telephone numbers should be posted by all telephones. Certain individuals must be made responsible for telephoning emergency numbers and giving adequate directions or instruction.

Recent years have seen total disaster befall a number of elevators who were not prepared with a disaster plan. Grain dust explosions have left people stranded on top of elevators with no way to reach them.

Electrical power was lost, rescue equipment was inadequate to reach injured employees and head counts were difficult to make following a severe tragedy.

A good emergency program is not complete unless everyone understands it and several drills have been conducted. Involve everyone possible connected with emergency services during a drill to be sure they are prepared.

Housekeeping

At any elevator you can find dust. The question is, How much dust can be found? And, where is the dust located? These two questions should guide your thinking when planning a clean-up and a continuous housekeeping program.

Grain dust is a natural occuring phenomena around elevators. Each time grain is moved or turned dust is present in large quantities. Dust cannot be eliminated so we use the next best approach and try to control it. Regardless of our unwillingness to use them, the broom and dust pan are still the number one pieces of equipment in elevator housekeeping.

Sophisticated fabric filters and large ducts only aid in a good control program. We must do the rest using a broom.

Many elevators are constructed of concrete. Concrete by nature has a rough surface and coarse texture. Grain dust easily settles on rough surfaces and attaches itself. Adequate surface finish work and a good coat of paint will help smooth concrete surfaces. Then during the process of cleaning a simple brushing of the walls and ceilings removes the dust before build-up occurs.

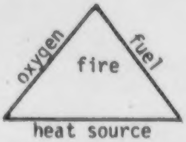
Adequate cleaning schedules are difficult to suggest because of the different volumes of grain handled. However, at least once a week a major cleaning of the elevator should be conducted. The best program is a daily sweeping. By sweeping certain areas daily you automatically develop an overall housekeeping program that eliminates the big seasonal house cleaning. A continuous program sweeps a different area daily, but sweeps it thoroughly. Consequently the total housekeeping chore becomes less burdensome, less time consuming by attacking a small part of it daily.

Extra care and attention should be given to overhead structures and ceilings. Ledges tend to accumulate dust that is unseen but is many times more dangerous because of its ability to fall and create a dust cloud of suspended particles. Dust particles in suspension more readily lend themselves to explosions and flash fires.

Dust Explosions

Dust explosions are a difficult phenomena to explain. They have occurred for a number of years in elevators. Frequently the devastating results do not leave sufficient evidence behind to piece the probable cause back together. It is known however that grain dust will smolder and burn. It is also known and can be demonstrated that fine grain dust suspended in the air will burn so quickly that it literally explodes in a flash fire with thousands of pounds of force.

For a fire of any kind to burn it requires three things. It requires a fuel, oxygen and a heat source hot enough to reach kindling temperatures of the fuel. Scientist and industry experts call this the fire triangle.



To control a fire then at least one of the supportive ingredients must be eliminated. To eliminate the fuel (dust) inan elevator is virtually impossible. Any time grain is present, so is grain dust. Oxygen is found in the atmosphere in sufficient quantities to support combustion so that becomes impractical to control. The third ingredient is the heat source and is the one area that must be controlled.

There are numerous ways sufficient heat can be generated around an elevator. We will discuss the most obvious and most frequent sources. A common error is welding and cutting with torches in elevators. Repair of equipment and sometimes construction work finds welding being done in elevators. There is only one solution to this heat sorce and that is DO NOT WELD in elevators when they are in operation. Develop a shut down and clean up program before welding and cutting operations begin. Allow a minimum of 30 minutes to pass following shut down before welding and cutting.

Another likely area where heat can be generated is from friction. Friction from slipping belts, belts running out of line or two pieces of equipment rubbing together. Also involved with friction is overheated bearings. Bearings require proper and adequate lubrication to cool and carry heat away. Bearings improperly lubricated or not mounted correctly can provide sufficient temperatures to reach kindling temperatures for dust. Allowing dust build-up on bearings prevents the escape of heat and provides a ready source of ignition.

Electrical equipment can be another area that provides sufficient heat to ignite dust particles. Electrical energy may come from faulty wiring, inadequate grounding, overloaded motors, exposed lightbulbs and lack of class II group G electrical equipment in dusty areas.

At this point it should be pointed out that everything mentioned so far relates directly to maintenance. Poor or inadequate maintenance is a contributing factor in several dust explosions. And poor maintenance is a direct result of human error - the single biggest cause of accidents.

Other possible sources of heat are from metal sparks, static electricity, lightening, truck and tractor exhausts and burning cigarettes. We must do all that we can to eliminate each one of the fire hazards from the elevator. Daily remind yourself of the possible hazards and keep your elevator facilities clean and in good repair.

The fabric dust filter and collector is designed to operate at maximum efficiency. Anytime the system drops below this efficiency level the bags plug up, the dust settles out in the ducts and the system which was designed to assist in cleaning the elevator now becomes the problem and is potentially dangerous.

Equipment Safety

Equipment safety can be divided into two topics. Equipment that is used by an employee in the performance of his job and personal safety equipment worn by individual employees for their own protection.

An example of equipment used by employees are the caged manlift, truck lift and the bag filter dust collection system. Personal safety equipment would be such items as goggles, respirators, gas mask, and hard hats.

The larger equipment that is found in the elevator as part of the machinery will be covered in detail under maintenance. However, at this time it should be pointed out that all equipment has a safe operating limit. If that limit is exceeded, a foolish injury, perhaps death, may result in someone. Specifically think of the three items previously mentioned - the caged manlift, the truck lift and the dust collection system. If the maximum weight or load limit is exceeded the equipment is put under a strain. In some cases the damage is not readily visible. Equipment fatigue will ultimately cause failure when you least expect it or under heavy use will fail when you can least afford it.

All caged manlifts have a load limit that is visible to the operator. Generally manlifts rated for one person have a limit of 250-300 pounds. Two man or multiple manlifts in country elevators are very uncommon. Most country elevators have only the single man caged manlifts. Overloading the manlift with two or three individuals is dangerous and foolish. The little bit of time saved may be spent recuperating in a hospital. Fractured bones or internal injuries are painful reminders of shortcuts.

Construction crews are prone to violate the load limit on manlifts by moving heavy equipment from top to bottom. You must remember that after the repair or construction crews leave your elevator the damaged manlift is left behind for you to use. Do not feel awkward or embarrassed in asking the repair crew to stop their use of the manlift or comply with company regulations not to exceed the load limit.

Truck lifts were designed to hoist small trucks into an elevated position for dumping grain. The maximum lifting weight can be surpassed, but irrepairable damage may have occurred. Larger trucks may be dropped because the brake on the hoist fails. Improper operation of the truck hoist such as start - stop jerks to slide grain from the truck box may bounce the truck wheels off of the cradle.

Four wheel drive pickups and trucks that are locked in gear with power-lock differentials can present special situations an elevator operator should avoid. The possibility exist that the vehicle during lifting could have the front wheels rotate and literally roll off the cradle dropping to the floor. When in doubt exercise the privilege of refusing to lift a truck until you have consulted the manager. Do not yield to coaxing by the driver to go ahead. That sort of error in judgement could cost you your job.

Place the trucks front wheels on the cradle, lift the truck two-three inches to position. Have the driver turn off the ignition, leave the truck in neutral and exit from the cab to a safe location. Lift the truck in two or three lifting sequences with smooth gentle starts and stops. DO NOT BOUNCE the truck and do not exceed maximum lifting height.

In reference to the smaller personal safety equipment the most frequent violation is failure to use the equipment provided. For some unexplainable reason we are sure an accident will never happen to us and we avoid using the very equipment which was designed and purchased for our welfare. The second problem is proper instructions and understanding on the users behalf. We assume everyone knows how to use a particular piece of equipment because they have seen it. Constant practice, instruction and repeated drilling is the only sure way to be confident everyone understands how to use safety equipment properly.

The greatest fallacy with breathing apparatus is the assumption that gas masks protects you totally. In reality gas masks are only filter devices and remove harmful gases from the air we breathe.

There-in lies the danger. Many gases, particularly fumigants, are heavier than air. Consequently, gases settle into low areas and force out all of the air. In reality, a person would suffocate in this area of high gas concentration because the air or oxygen we breathe has been displaced by fumigant and in these particular cases a gas mask as a filtering device would be inadequate because no air remains to be filtered.

A second problem that individuals face is that gas mask canisters are gas specific. They are designed to filter only one type of harmful gas from the air. One canister cannot be substituted for another. You must know which gas you are using and which canister is required for protection. To eliminate out-dating of canisters, their selectivity, and their limited filtering ability, self contained breathing apparatuses are being recommended.

Self-contained breathing apparatuses, provide a constant air supply for a specified time period. A pressurizied bottle carrying the air is strapped to the back or slung over the shoulder. Air tanks can be recharged, they have no outdating time use and they can be used in any lethal environment.

Accidents from Falls

The National Safety Council lists falls as one of the primary causes of accidental deaths. The grain elevator is no exception and each year several hundred falling accidents kill and permanently cripple employees.

Falls from ladders is a problem area. This has led OSHA to initiate rules and regulations and closely monitor all ladders. Fixed or permanent ladders must contain some permanent safety precautions. Generally the entire ladder is enclosed, however a safety belt worn by the employee maybe attached to a fixed cable or pipe for added protection against falls. Other checks should be made for missing rungs, loose cleats, insufficient toe space-(7 inches minimum) loose mountings and adequate access at the bottom and the top. Portable ladders cause more problems around elevators than do permanent ladders. Portable ladders must be of sufficient length to adequately do the job. Rubber feet are to be mounted on the bottom of the legs to prevent sliding. Portable ladders are to be of heavy duty construction and carry an industrial rating. If the portable ladders are of wood construction they cannot be painted or have any cracked or broken steps. Ladders that are home-made for short temporary use are cited by OSHA and the state health inspectors as a violation of the law.

Employees tend to abuse ladders - particularly portable ladders - and give them rough treatment. Part of the problem is from improper use. Over extending ladders, reaching for ladders, poor placement or footing and incorrect angles are all causes of falls from ladders. All too frequently employees think they are ladder experts and attempt to climb one handed or do not face the ladder when climbing. Either situation may result in a fall from a ladder. The recommended angle of placement against a verticle structure is between 65 and 75 degrees. If the ladder is too straight you may fall backwards. If the ladder is leaning excessively it may slide down the building after loosing its footing.

Falls from tripping, stumbling and sliding on loose grain are problems at the elevator. Power cords, ropes and cables are frequently used and strung around grain elevators. Care should be exercised in placing such equipment on the work floor. Other employees must be protected and warned of the hazard. Always replace equipment in its proper storage location. Do not leave the work area cluttered with equipment that can be tripped over.

Loose grain left on concrete and wood floors cause falling accidents. A fall from careless housekeeping or failure to sweep up grain from the floor is inexcuseable. Any spill should be cleaned up immediately by the employees involved. Do not delay in taking quick cleaning action to prevent a fall.

Stairs to different work levels and loading docks may also cause falls. Improper stair treads or tread intervals of different heights can be a contributing factor to falls. Handrails must be provided on all stairs with a mid-rail to prevent falls. In addition, any walking or working surface that is 48 inches above the main work area must have a protective top-rail, mid-rail, and bottom kick plate.

Lifting Accidents

Each year thousands of employment hours are lost because of back injuries. Most country elevators maintain a warehouse for farm supplies. Employees must stack, load and unload items on a daily basis. Back strains may be the result of improper lifting, poor support of a heavy load or maintaining an awkward position while trying to do heavy demanding work.

Several tips to proper lifting along with good common sense can help prevent back strain.

1. Get help in lifting heavy loads.
2. Lift with you legs, not your back.
3. Do Not Lift and turn or twist at the same time.
4. Do Not Catch a falling object or heavy weight.
5. Maintain a clear path with good vision to prevent falling with a loading.
6. Use dolly's and portable trucks to move heavy objects rather than brute strength.

Bin Entry Safety

Entering any confined or enclosed space should be regarded as dangerous. Do not take this task lightly or without proper supervision. Sufficient help and adequate equipment are too important essentials.

Bin entry permits are the best practice to follow. A bin entry permit states the reason entry is necessary, when entry will be made, who will make the entry, what equipment is needed and who authorized the permit.

SAMPLE PERMIT

Bin Entry is requested on __________ (date)

at __________ (time) for the purpose of

(explanation) ______________________________

____

____

The following equipment has been secured and

checked and the necessary safety precautions

listed below have been observed. __________

____

____

(employee signature) (Mgr. signature)

A bin entry permit should not be issued for any length of time greater than a half a day. If the job will require a longer period of time obtain a second permit. This prevents errors on anyones part thinking a job was completed before lunch. A permit should also be in duplicate copy. One copy kept at the managers desk and the second copy carried by the employee requesting the permit. When the work is complete report back to management, return the permit copy and everyone is informed that the job is finished.

The following list of items should be part of the permit check list.

1. Enter bins only after careful consideration and when absolutely necessary. (after securing a permit)

2. Open up the grain bin and aerate to remove toxic or lethal gases.

3. Visually inspect the bin from top and bottom and plan your entry, your work and your exit.

4. Lock out all electrical equipment such as augers, belts and other mechnical devices.

5. Always have two responsible individuals outside the bin that understand emergency procedures.

6. Never enter a bin alone and do not enter while grain is being emptied. Be alert to possible bridging of grain or hanging up on the sidewalls.

7. Use adequate equipment.

--hand winch with 3/8" steel cable

--botswains chair and harness

--safety belt and safety harness

--safety rope of 1/2 inch nylon

--respirators or dust mask (self contained breathing apparatus if the air purity is questionable)

--approved portable light or drop light

--duplicate stand-by equipment for emergencies.

Fire Equipment Safety

Everyone knows how to operate a fire extinguisher? WRONG!! That is an invalid assumption to make without adequate training and practice. Under emergency and panic situations people forget such simple things as pulling the pin or first inverting the extinguisher.

An initial problem is to identify the source of the fire and determine its classification. Fires have been classified according to types by a lettering system.

Class A - Ordinary combustibles such as paper, wood and other organic materials.

Class B - Petroleum fires such as oil, gasoline, and grease.

Class C - Electrical fires or energized circuits.

Class D - Combustible metals such as magnesium.

Obviously, water would take care of class A fire, but do a very poor job on any of the others. In fact water used on a class C fire could prove fatal and water used on a class B fire would only spread the fire.

Fire extinguishers are now made for multiple purpose use and are classified as A-B-C Extinguishers. However, if the extinguisher is for a specific type of fire you should know how to use it and on which type of fire it is to be used. (Consult your local fire department for additional information and instructions.)

Grain Fumigant Safety

Another area that involves personal safety is dealing with agricultural chemicals. Many agricultural chemicals were designed to kill or destroy, and grain fumigants are no different. The chemicals used to preserve grain quality serve two purposes. First, they protect the grain from harmful insect that will injure the individual kernels and lower the grain quality. Second, if a problem of insect infestation occurs a chemical is used to kill the insect through fumigation. Consequently, these chemicals are separated into two groups, either they are protectants or fumigants.

Protectants are chemicals that have a residual effect. They have the ability to remain potent or lethal to insects for several weeks, sometimes months. Generally protectants come in a powder form or a liquid form. The powder is dusted on and mixed into the grain as it goes into storage. The liquid protectants are sprayed on both the storage bin and the grain.

Whenever the insect comes in contact with a protectant it does so by walking over a treated surface. Through the feeding process and coming in contact with the protectant insects are destroyed and the grain is protected from an infestation. Several good protectants are on the market under various labels. However, two principle chemicals are used. They are Malathion or Methoxychlor.

The fumigant group of chemicals share one common and unique characteristic. Regardless of their original form they all turn into a gaseous state. It is the gas form or fumes of the chemical that attacks the insects nervous system and kills them. The original chemical is in a solid pellet state, or a liquid form but the process is the same, a gas is produced. Some liquid fumigants, such as chloropecrin and carbon tetrachloride, turn into a gas immediately. Others like methyl bromide are in the gaseous state at normal room temperatures.

Several liquids maybe mixed together by the manufacturer to deliver greater killing strength or provide longer fumigant duration. The basic liquid fumigant used is carbon tetrachloride while carbon disulphide, ethlene dichloride and pyritherins are added for special killing effects.

With nearly every fumigant the gas that is generated is heavier than air. This poses a special hazard to elevator employees. Low areas in grain elevators collect heavier concentrations of the toxic fumes within a few hours of application and lasting for several days. Fumigants are lethal to individuals as well as insects.

Undisturbed or undiluted killing concentrations found in lower areas of the elevator present an extremely hazardous situations. The percentage concentration is unknown and frequently not measured by individuals venturing into those parts of the elevator. It must be assumed by the employee that all atmospheres are lethal and adequate protective equipment must be worn.

Two types of equipment are available for protection against fumigants. One is a filtering device that removes the harmful gas and lets you breathe clean air. The other protection is a self-contained breathing system that provides air from a pressurized cylinder.

There is a significant difference in original purchase price between the two protective pieces, but there is also a significant difference in the protection and employee comfort. Both systems are a protective mask. One connects to a filter canister and the other connects to a regulator and pressurized tank.

Bare in mind that the canister filter device has three limitations. First the canister must be current and not outdated. Second, it must be gas specific for the fumigant being used. Third, the canister is limited in filtering capacity based on the concentration of gas and the breathing demands of the individual. The length of service received from a canister is unpredictable then because of these limitations. The self contained system is limited only in its available service time based on the individuals breathing demands and its cumbersome size.

The advantages, however, outweigh the limitations. The contents of the pressurized cylinder is air and can be taken into any environment including dusty bins. Air tanks can be refilled and used over and over, they do not have a dated shelf life. Since it provides air it can be worn in air deficient areas where heavy concentrations of fumigants have displaced the air. An employee trying to use a canister in an air deficient area would suffocate. After, filtering out the fumigant there is no air to breathe.

MSA Gas Mask Canisters

MSA manufactures four canister models: Type No, Super Size, Industrial Size, and Chin Type. The model to use depends upon type and concentration of contaminant and length of service life required.

MSA canisters are seamless and, except for the aluminum Chin Type canister, are made of steel. The compact oval shape makes the canister easy to use and store. Canister connector is threaded, and a sealing tape seals the bottom air intake to assure fresh chemical sorbents by preventing moisture from entering the canister before use.

Canister, Type N

MSA Gas Mask Canisters: Chin Type, Industrial Size, Super Size, and Type N

An adjustable universal-size harness consisting of webbing and a cover shell is used to support Type N, Super Size, and Industrial Size Canisters. Tubular nylon webbing resists chemicals and moisture, is easily cleaned and sanitized, and keeps its snug fit indefinitely.

The rigid, injection-molded nylon shell fits over the top of the seamless canister and is held in place by the harness webbing: it is easily removed for canister change. Harnesses for either front or back mounting are available.

A series of Industrial Size Canisters with D-rings attached to the canister shell for wear with a single webbed strap are available on special order.

Gas Mask Carrying Cases

All Industrial and Super Size Gas Masks are supplied in one-piece molded plastic carrying cases. Cases have no metal parts. Two canisters are supplied with Super Size masks; one canister is supplied with Industrial and Chin-type masks. The Chin-type mask is supplied in a more compact case.

Carrying cases for Industrial, Super Size, and Type N Gas Masks (left) and Chin Type Gas Masks (right)

Canister Selection

Each canister is specially labeled as to type and limitations and is color coded for fast and accurate recognition through the color of the canister itself and the stripes of high-visibility, pressure-sensitive tape on the top and/or bottom.

The U.S. Bureau of Mines previously tested and approved gas masks under Schedule 14 for respiratory protection against specific gases and vapors in concentrations up to 2 percent by volume (3 percent ammonia) or as specified on the canister label. (Exceptions are the Super Size Gas Mask for vinyl chloride which has been tested and approved by NIOSH/MESA for respiratory protection against not more than 25 ppm vinyl chloride for not more than 4 hours or until the end of the work shift in which it is first used, whichever comes first, and four types of chin masks which also have NIOSH/MESA approval. NIOSH/MESA has plans to extend its gas-mask testing and certification program in the future). Chin Type Canisters, because of their smaller size, should be limited to concentrations not in excess of 0.5 percent by volume.

Most MSA canisters contain particulate filters for the removal of dust and certain other particulate matter, as indicated by a gray stripe around the top of the canister. This makes the mask dual purpose-protects against both gaseous and particulate contaminants, and eliminates stocking canisters for special use in situations where toxic aerosols may be present. Certain canisters also have a high-efficiency Ultra-Filter element which protects against more toxic and finely divided matter.

The canister selection chart shows the MSA canisters and gas masks available for various contaminants.

Use the Correct Canister for the Fumigant

On the attached list are some of the most commonly used products in Kansas. As you were aware, different chemicals give off different types of toxic fumes or gases. Reference the type you are using and make sure you are using the correct color canister for the product you are using.

REMEMBER! There is no safe grain fumigant. All contain agents which are deadly to human beings.

In the state of Kansas, anytime there is a mixture of organic vapor and acid gas in one fumigant which calls for a yellow canister, the mask must be equipped with a super-sized yellow canister. The Bureau of Labor inspectors of Kansas have requested the recently approved canister for phosphine that protects for concentrations less than .5 volume percent.*

BRAND NAME & CHEMICAL CONTENT		USE CANISTER TO PROTECT AGAINST
COOP. WEEVIL KILLER GRAIN CONDITIONER		
Ethylene Dichloride	70.5	Organic Vapors & Acid Gases (Yellow)
Carbon Tetrachloride	23.5	
Ethylene Dibromide	3.0	
Sulphur Dioxide	3.0	
CYANOGAS		
Calcium Cyanide	42.0	Hydrocyanic Acid Gases (White with green stripe)
Inert Ingredients	58.0	
LARVICIDE		
Chloropicrin	99.0	Organic Vapors & Acid Gases (Yellow)
Inert Ingredients	1.0	
MAX-KILL 10		
Carbon Tetrachloride	80.5	Organic Vapors (Black)
Carbon Bisulfide	16.5	
Methylene Chloride	2.0	
Ethylene Dibromide	1.0	
PHOSTOXIN		
Alluminum Phosphide	55.0	MSA (Yellow with gray stripe) Wilson (Black with orange strip
Inert Ingredients	45.0	
WEEVIL KILLER & GRAIN CONDITIONER		
Ethylene Dichloride	68.5	Organic Vapors & Acid Gases (Yellow)
Carbon Tetrachloride	29.0	
Sulphur Dioxide	2.5	
WEEVIL-CIDE		
Carbon Tetrachloride		Organic Vapors & Acid Gases (Yellow)
Carbon Bisulfide		
Sulphur Dioxide		

*The following is a quotation from Bureau of Mines information circular 8291.

"The Bureau of Mines no longer recommends the Universal gas mask for protection against phosphine. Self-contained breathing apparatus is required for respiratory protection against concentrations of phosphine above 0.5 volume-percent."

N.I.O.S.H. — National Institute for Occupational Safety and Health has the responsibility for testing and certification of respiratory equipment under the authority of the Occupational Safety and Health Act. A N.I.O.S.H. approval insures that the product has been tested and is accepted by O.S.H.A. for use within the scope of its approval.

cannister selection chart

This chart is based on new recommendations from the gas mask companies. However, conditions and methods of applications as well as the length of time a person is exposed to the materials used may alter the recommendations somewhat. While the threads on one brand of cannister may fit the hose of another brand of mask, they should not be mixed. It must be remembered, gas masks cannot take the place of other precautions. This chart is intended only as a guide.

GRAIN FUMIGANTS

			CANISTERS WILLSON	MSA CANISTERS
CYANOGAS Calcium cyanide in granular form for fumigation in upright elevators				GMK 25-0023
LARVACIDE Packaged in one-pound bottles.				GMC-S(25-0024) GMA (25-0020)
PHOSTOXIN The grain fumigant in tablet form. An ideal fumigant for upright grain storage. Phostoxin contains aluminum phosphide which is a highly effective grain fumigant. Phostoxin begins releasing hydrogen phosphide in approximately four hours and is completely broken down in about five days.				GMC-SS-1 25-0025
PHOSTOXIN COATED PELLETS				GMC-SS-1 25-0025
CLOROFUME GRAIN FUMIGANT Carries the seal of Underwriter's Laboratories				
Contains Chloroform Carbon Disulfide Ethylene Dibromide	% by Weight 72.2 20.4 7.4	% by Volume 71.[illegible] 23.75 5.00	GID 25-0011	GMA 25-0020
Clorofume Grain Equipment (FC-30)				
Contains Chloroform Carbon Bisulfide Ethylene Dibromide	% by Weight 72.2 20.4 7.4	% by Volume 71.25 23.75 5.00	GID 25-0011	GMA 25-0020
GRAIN FUMIGANT (80/20 FIRE INHIBITED) - PLUS SO-2 (FC-15) Listed by fire underwriters				
Deodorized Petroleum Hydrocarbon Carbon Bisulfide Sulfur Dioxide Fire Inhibitor (Penatene)	 16.34 1.60 0.38	 19.55 1.25 1.00		GMC-S 25-0024 or GMC 25-0021
Fire Inhibited 80-20 (FC-14)				
Contains Carbon Tetrachloride Carbon Bisulfide Deodorized Petroleum Hydrocarbon 40	% by Weight 83.10 16.4	% by Volume 79.2 19.8	GID 25-0011	GMA 25-0020
80-15-5 Dibromide Mix, Fire Inhibited (FC-3)				
Contains Carbon Tetrachloride Carbon Bisulfide Ethylene Dibromide	% by Weight 8.13 12.1 6.6	% by Volume 80.0 15.0 5.0	GID 25-0011	GMA 25-0020
WEEVIL KILLER AND GRAIN CONDITIONER - NEW ACITIVATED (FC-[illegible]) Carriers the seal of Underwriters' Laboratories. Contains 65% ethylene dicloride, 27% carbon tetrachloride, 5% ethylene dibromide. Activated with 3% sulfur dioxide. Gives six times the post treatment protection of 8-/10				GMC-S 25-0024 or GMC 25-0021
ANHYDROUS AMMONIA			G4D 25-2067	GMD 25-2066

Gas Masks

MSA Type N Gas Mask with Ultravue Facepiece

MSA Super Size Gas Mask with Ultravue Facepiece (back-mounted harness)

MSA Industrial Size Gas Mask with Ultravue Facepiece

MSA Chin Type Gas Mask with Ultravue Facepiece

Application

MSA® Gas Masks are used for respiratory protection against certain gases, vapors, and particulate matter which otherwise might be harmful to life or health.

Because gas masks are air-purifying devices, designed solely to remove specific contaminants from the air, it is essential that their use be restricted to atmospheres which contain sufficient oxygen to support life (at least 19.5 percent by volume) and which contain generally no more than 2 percent concentrations of toxic gases and vapors by volume. It is imperative that the user assess the exposure conditions carefully before selecting a specific mask for respiratory protection. It is recommended that instruments be used to measure the concentration of oxygen and harmful gases and vapors present in the atmosphere under the various exposure and operating conditions.

If the specific exposure concentrations are suspected of exceeding the specific limitations—only a self-contained breathing apparatus or a hose mask with blower should be used.

From a practical standpoint, gas masks are generally suitable for ventilated areas with relatively stable concentration levels. They should never be used in confined spaces or where oxygen deficiency and high gaseous concentrations may occur.

WARNING: DO NOT USE FOR FIREFIGHTING

Description

Each MSA Gas Mask is a protective system consisting of the facepiece, breathing tube, harness, and a chemical-sorbent canister, specifically labeled and color coded to indicate the type of protection afforded.

Facepieces

Ultravue® Facepiece: Has a wide-vision lens and a speaking diaphragm. Lightweight (17 oz), easy to don. Facepiece is molded from a soft rubber compound which has high resistance to facial oils. It has a soft inturned peripheral lip and chin stop for good fit and tight seal. Headbands of the same rubber are attached to the facepiece by stainless steel quick-adjust roller buckles; the replaceable buckles are attached to the facepiece without rivets.

Lens is rugged polycarbonate and fits close to the eyes to afford unobstructed vision. Each lens is treated with Abcite* coating which resists scratching and chemical attack. The lens is securely sandwiched between a flexible, formed rubber groove in the periphery of the facepiece and the lens retaining ring.

A molded-in baffle serves as a deflector for exhaled air to reduce lens fogging; it also directs the voice to the speaking diaphragm to permit clear short-range conversation.

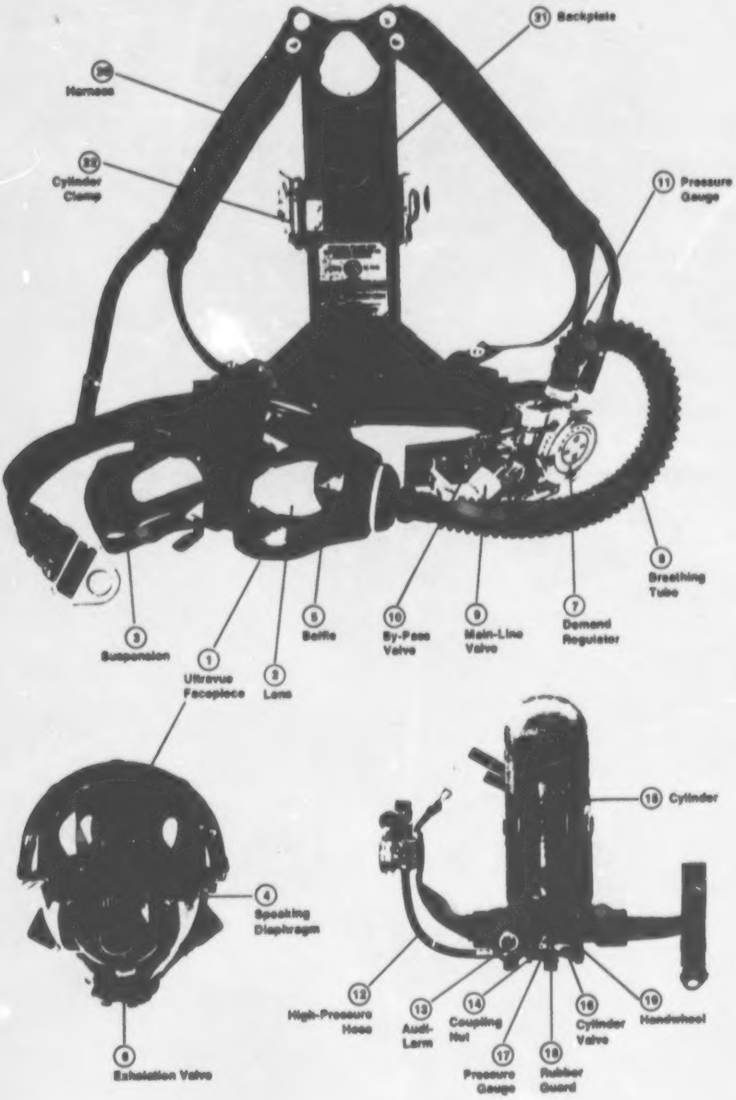
The facepiece has a universal coupling nut which permits quick disassembly for cleaning and also allows the facepiece to be interchanged with other MSA respiratory protection equipment. Most parts, including the lens, can be replaced in the field without special tools.

Clearvue® Facepiece: This wide-vision facepiece with speaking diaphragm is available on special order. Unit may be equipped with an MSA ClearCom Amplifying unit or a Maskfone™ Sound Powered Communications device for communications in high-noise areas.

Accessories are available for use with either facepiece: a spectacle kit for prescription lenses, a nosecup to reduce the possibility of lens fogging under low temperature and/or high humidity conditions, and a welders adapter which permits the attachment of large welding plates.

The Ultravue Facepiece and Clearvue Facepiece are NIOSH/MESA approved with most types of MSA respiratory protection equipment.

*Trademark of E. I. du Pont de Nemours and Co. (Inc.)


21 Backplate
20 Harness
22 Cylinder Clamp
11 Pressure Gauge
8 Breathing Tube
7 Demand Regulator
9 Main-Line Valve
10 By-Pass Valve
5 Baffle
3 Suspension
1 Ultravue Facepiece
2 Lens
15 Cylinder
4 Speaking Diaphragm
6 Exhalation Valve
12 High-Pressure Hose
13 Audi-Larm
14 Coupling Nut
17 Pressure Gauge
18 Rubber Guard
16 Cylinder Valve
19 Handwheel

Additional protective clothing should be worn by individuals working around grain protectants and fumigants. Always read the label and follow specific guidelines provided in the instructions. A head covering or cap should be worn as well as coveralls and rubber boots. This will aid in preventing spills, falling on the inside of the boots. Always change out of fumigant or protectant treating clothing immediately and wash exposed body parts with warm water and soap.

The following 12 steps should be observed by all individuals involved in treating stored grain.

1. Never work or permit others to work alone. Always remain in the line of sight of the other employee.

2. Wear proper respiratory equipment. Both men should be adequately equipped with protective equipment.

3. Take advantage of all ventilation and wind currents. Anytime a fumigation is being conducted windows should be opened and fans turned on. Be especially careful of fumigating on quiet days where there is no natural movement of air.

4. Never enter a bin or other area without first preplanning a quick method of escape in case of an emergency.

5. Remain as far away from the point of application of the fumigant as possible.

6. Return to fresh air immediately upon the slightest odor of the fumigant or when you have difficulty breathing. Never attempt to continue an operation where conditions of safety are doubtful.

7. Never short cut an application procedure. Bare in mind that there is only one safe way to do any job.

8. Never work in a fumigation operation when you have a head cold or any other condition which might impair your sense of smell. Be especially alert to conditions which might inflict injury to yourself. A slight scratch could bring an excessive amount of breathing or cause a frantic feeling that could lead to trouble.

9. Prior to starting fumigation, make sure that everyone is notified. Post warning signs at all entry and exit openings.

10. All men involved in fumigation should have an extra set of clothing to change into immediately after the fumigation is completed.

11. Read the label on the fumigant that is being used and let your doctor know the ingredients. If necessary he can have an antidote immediately available. It is a good idea to have posted by each telephone all emergency numbers.

12. Some employees, specifically older men think they have a built in resistance to fumigants and have no need for protective equipment. Keep in mind that any fumigant that is strong enough to kill insects, is also strong enough to kill an individual. DO NOT TAKE FOOLISH CHANCES!!

Employees who spend considerable time in dust environments without adequate respiratory equipment can suffer "millers lung" or "brown lung". This is an inphasema type disease which renders the lungs useless because of dust collections in the lungs. A very similar condition to coal miners black lung from coal dust. Be responsible and use good judgement. Wear dust mask and respiratory that are NIOSH approved. They are your lungs - take care of them.

Labels

Reading and understanding labels is not difficult! Before using any product the label must be read and thoroughly understood. Individual safety as well as proper use of the product is at stake. Recent moves by government agencies and product manufactures have provided more information to the end user by way of the label.

Several steps need to be followed in the process of becoming familiar with a product and knowing what the label actually says. Follow through the five steps given below and study the two sample label panels - existing or old label and future or new label.

Terms and Definitions

Active ingredient - That part of a pesticide product which will kill or control pests or prevent damage by them. (Note: This is the poison in the product).

Label - Form of printed material attached to or printed on a pesticide container.

Labeling - Technical information in the form of printed material provided by the manufacturer or its agent.

Insecticide - Chemical or other material that will destroy or control an insect or protect something from an insect.

Signal words - Words which must appear on pesticide labels to show toxicity of pesticide.

Toxic - Poisonous; ability to cause injury to plants and animals, including humans.

When to read the label: If it cost several million dollars to develop a product and get it labeled, surely we can take the time to read the label.

1. Before use when making a selection.
2. Before mixing or applying.
3. Before storing or disposing of containers.

Classification of insecticides

1. General Use - Pesticide use that will not cause excessive damage to the environment or endanger the applicator or other persons when applied according to label directions.
2. Restricted Use - Pesticide use that may be a hazard to the environment, the applicator, or other persons even when label directions are followed.

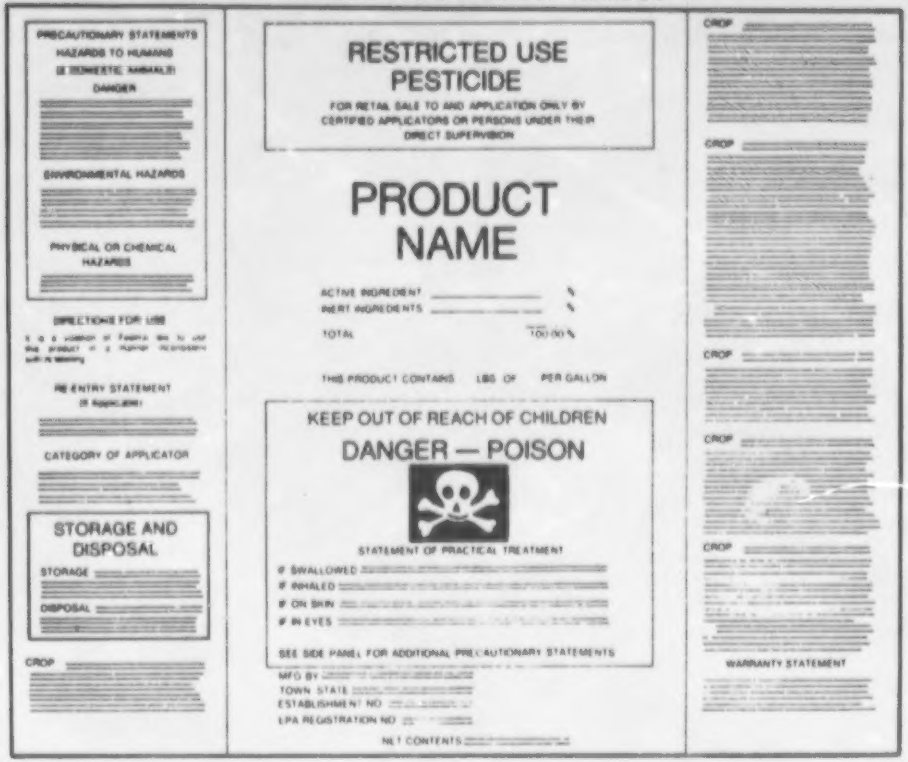
Facts contained on the label (See following page)

1. Name and address of chemical company
2. Brand (trade) name
3. Name and amounts of all active ingredients
   (NOTE: The label will also list the amounts of inert ingredients.)
4. Type of pesticide
5. Kind of formulation
6. EPA registration and establishment numbers
7. Storage and disposal precautions
8. Hazard statement
   (NOTE: This statement describes environmental hazards, human hazards, animal and plant hazards, and physical and chemical hazards.)
9. Directions for use
10. Net contents

Names found on labels

1. Brand name - Name used by a manufacturer to identify a pesticide as their product.
   (NOTE: The brand name may not be used in the ingredient statement but usually appears in large, bold-faced letters on the packaging. One brand name, such as Ortho, may appear on the label of several different kinds of pesticide chemicals.)

Future Pesticide Label



PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS
(& DOMESTIC ANIMALS)
DANGER

ENVIRONMENTAL HAZARDS

PHYSICAL OR CHEMICAL HAZARDS

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

RE-ENTRY STATEMENT
(If Applicable)

CATEGORY OF APPLICATOR

STORAGE AND DISPOSAL

STORAGE

DISPOSAL

CROP

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION

PRODUCT NAME

ACTIVE INGREDIENT ______ %
INERT INGREDIENTS ______ %
TOTAL 100.00 %

THIS PRODUCT CONTAINS LBS OF PER GALLON

KEEP OUT OF REACH OF CHILDREN

DANGER — POISON

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED
IF INHALED
IF ON SKIN
IF IN EYES

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

MFD BY
TOWN, STATE
ESTABLISHMENT NO.
EPA REGISTRATION NO.

NET CONTENTS

CROP

CROP

CROP

CROP

CROP

WARRANTY STATEMENT

CLASS EXERCISE

Select any one of the fumigants from the classroom file of labels. You may choose a product you have used or one you are unfamiliar with. Answer the following questions from the label.

1. Is it classified General or Restricted Use?

____

2. What is the Brand or Trade Name? ______________________

3. List the name and amounts of the Active Ingredients.

   A. ____________________ ____________________

   B. ____________________ ____________________

   C. ____________________ ____________________

4. What information is contained in the Hazardous Statement?

____

5. What is the net contents of the container?

____

6. How are the containers to be disposed of?

____

7. What are the directions for mixing and using?

____

8. Give the Chemical name. ______________________

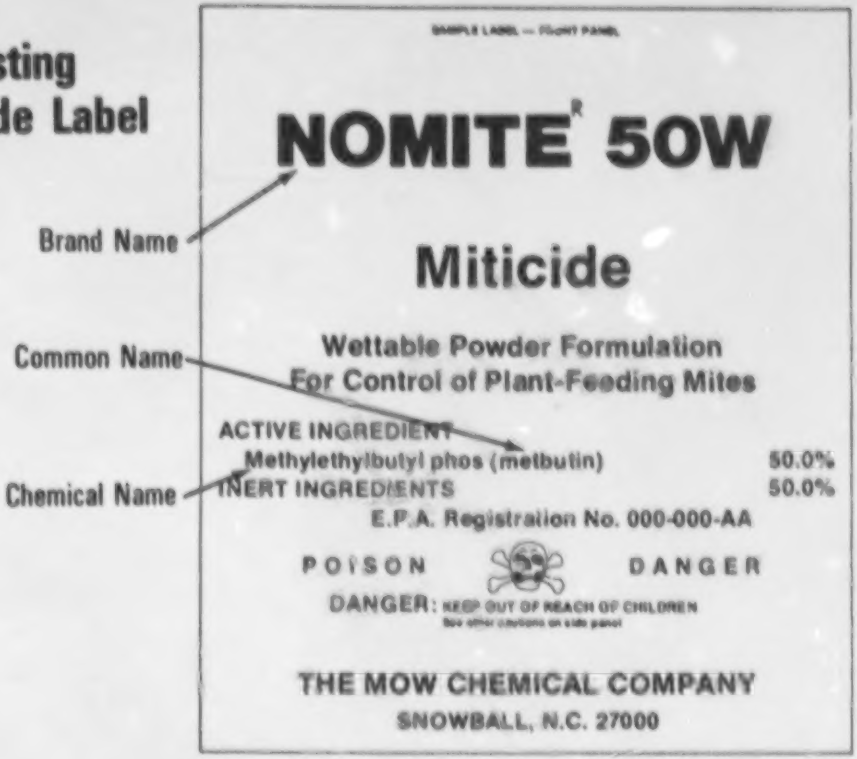
9. Write the Signal Word that appears on the label.

____

10. List the Target Pest this product is labeled for?

____

Existing Pesticide Label



Brand Name

Common Name

Chemical Name

SAMPLE LABEL — FRONT PANEL

NOMITE® 50W

Miticide

Wettable Powder Formulation
For Control of Plant-Feeding Mites

ACTIVE INGREDIENT
Methylethylbutyl phos (metbutin) 50.0%
INERT INGREDIENTS 50.0%

E.P.A. Registration No. 000-000-AA

POISON DANGER

DANGER: KEEP OUT OF REACH OF CHILDREN
See other cautions on side panel

THE MOW CHEMICAL COMPANY
SNOWBALL, N.C. 27000

2. Common name - Well-known, made-up name accepted by the Environmental Protection Agency to identify the actual poison in a pesticide.
   (NOTE: The common name must be used in the active ingredients section on the label and is usually not capitalized.)

3. Chemical name - Scientific "often complicated" name which tells what the active ingredients or actual poisons are.
   (NOTE: When an accepted common name is not available, the chemical name must be used to name the active ingredients in the ingredient section of the label. Often both the chemical name and the common name appear.)

Government Agencies

Two federal government agencies are interested in maintaining a safe and healthy work environment for all employees and all Americans. OSHA (Occupational Safety and Health Act) made it law that employees must be protected. EPA (Environmental Protection Agency) is interested in keeping the outdoor air and environment clean and free of contaminants. In many states the Department of Health is charged with the responsibility of supervising the state laws and enforcing regulations.

NIOSH (National Institute of Occupational Safety and Health) is charged with the responsibility of education and approving safe and adequate equipment. Equipment either meets OSHA standards or it doesn't. OSHA does not approve equipment either, that is NIOSH who performs that function. OSHA merely accepts or rejects equipment according to standards and law.

The following list consists of common violations OSHA was finding on elevator inspections during 1978-1979.

1. Unguarded floor and wall openings.
2. No safety belts provided for high work conditions.
3. Misuse of compressed air, cleaning clothes.
4. Oxygen and acetylene cylinders stored together.
5. Uncapped gas cylinders.
6. Inoperable horns on forklifts.
7. Smoking in undesignated areas.
8. Open motors and non-dust-ignition-proof wiring.
9. Improperly made ladders.

10. Lack of guards on temporary lights.

11. Fire extinguishers not properly charged.

12. Lack of venting and motion sensors on grain legs.

13. Poor or inadequate housekeeping and maintenance.

In addition to the above list, your employer must comply with numerous other requirements. Some of the most frequently mentioned items are given in this partial list of OSHA elevator compliance suggestions.

1. A plant emergency organization, including maintenance of fire extinguishing equipment and trained personnel.

2. A certified first aid attendant on each shift and a first aid kit available.

3. Recorded safety meetings, plant inspections and evidence of deficiency corrections.

4. Stairways with handrails, good treads, non-slip, free of material such as oil, resin, grain, etc.

5. Warehouses with materials piled safely and aisles clear and free of obstruction.

6. Good housekeeping in all areas of your operations.

7. Guards on all machinery drives, stationary, portable, and temporary.

8. Overhead guards on all forklifts, front end loaders, and tramming equipment.

9. Globes on all lights, suitable for the various atmospheres.

10. All electrical equipment should be grounded, visible grounds on all motors.

11. All receptacles covered and no temporary wiring to permanent outlets.

12. All hand tools in good condition, grounded, double insulated.

13. Safety cages on all permanent vertical ladders.

14. Safety hooks on chain hoists.

15. Hard hats worn in construction areas.

16. Eye protection devices worn where needed.

17. Adequate lockers and restrooms provided.

18. OSHA posters displayed in prominent places.

19. Emergency communication available between plant areas of operation.

20. All exits and non-exits properly identified.

21. Fans within 7 feet of the floor provided with mesh guards.

22. Platforms with standard handrails and toeboards, removeable on loading areas.

23. Provide employees with ear protection where high noise levels exist.

24. Post information relative to toxicity, flammability, and reactivity of hazardous products used in your areas of operations.

CHAPTER III

GRAIN GRADING AND SEED IDENTIFICATION

CHAPTER OBJECTIVES

After the completion of this chapter the student should be able to:

1. Identify by listing the common name of crop and weed seeds.
2. Recognize the quality determining factors of grain.
3. Grade grains handled in the elevator using Federal Grading Standards.

TEACHING AIDS

1. Collect as many different crop and weed seeds that are common to your area.
2. I.D. samples and grain grading samples may be secured from the Agronomy department, Kansas State University, Manhattan, Kansas, Government Grain Grading Offices, University of Illinois at Urbana and Nasco Catalog.
3. "Some Identifying Characteristics of 60 Crop and Weed Seeds," Ohio Agricultural Education Curriculum Materials Service, slides.
4. "Wheat, Corn and Grain Sorghum Grain Inspection Methods", Seedburo Equipment Company.
5. The following equipment is recommended to teach government grain grading procedures to a class of 15-20 students.
    a. 2 different moisture testers
    b. Boerner divider
    c. Strand sizer shaker
    d. Grain sieves and pans for the grains you plan to grade
    e. Thermometers
    f. Two 500 grain scales with dockage % calibrations
    g. Weight per bushel tester with filling hopper and stand
    h. 63 inch grain probe
    i. Sample pans
    j. Large supply of gallon containers (plastic or metal) to store grain samples in
    k. Large grain tweezers
    l. Magnifying glasses

6. Seed Grading Factor Slides, Farmland Industries, Inc.

7. "Methods of Grading Wheat," mini-course Ag-Education Department, Kansas State University, Manhattan, Kansas.

SUPPLEMENTAL REFERENCES

1. "The Official U.S. Standards for Grain," U.S. Department of Agriculture.

2. "Seedburo Official Grain Grading," charts, Seedburo Inc., 1022 W. Jackson Blvd., Chicago, Illinois.

3. Corn Kernel Damage, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, L-59.

4. Soybean Kernel Damage, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, L-57.

5. Grain Sorghum Kernel Damage, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, L-58.

6. Wheat Grading Factors, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, L-19.

7. Sick Wheat, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, C-321.

8. Oat Kernel Damage, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, L-103.

9. Procedures, for Hand Sieving Wheat, Corn, Sorghum and Soybeans to Determine Quality Grade, Kansas State University, MF-436.

STUDENT STUDY GUIDE

References: (1) "The Official United States Standards for Grain."
(2) "Seedburo Official Grain Grading," charts.

1. Crop and Weed Identification
   The student should study actual seed samples and refer to the seed descriptions for basic identifying characteristics. Several periodical identification exams should be given over the seeds.

2. Grain Grading Definitions
   The student should look up and fill in all the definitions on the included page.

3. Wheat Grading Questions
   The student should answer these questions pertaining to the official grading of wheat.

4. Wheat Grading Exercise
   The student should use the information pertaining to each sample of wheat and put an official grade on it.

5. Procedures for Offically Grading Wheat
   The instructor should go through this material and explain how the information shown in No. 4 was arrived at. Also show the differences in sieves used.

6. Corn Grading Questions
   The student should answer these questions pertaining to the official grading of corn.

7. Corn Grading Exercise
   The student should use the information pertaining to each sample of corn and put an officially grade on it.

8. Procedures for Officially Grading Corn
   The instructor should go through this material and explain how the information shown in No. 7 was arrived at. Also show the differences in sieves used.

9. Grain Sorghum Grading Exercise
   The student should use the information pertaining to each sample of sorghum and put an official grade on it. This is easy to understand once the principles of the previous grains are understood.

10. Precautions to Observe in Grading Grain
    The instructor should discuss this with the class.

11. Grain Grading at the Local Elevator
    The instructor should go through this with the class and compare it with the government grading standards.

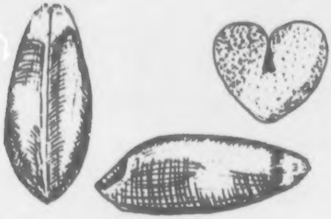
12. Identification of Farm Grain Storage Damages
    The instructor should supply samples of grain that have the types of damage that might occur on the farm.

13. Procedures for Sieving Grains to Determine Quality and Grade
    The instructor should go through a step by step procedure of grading each type of grain. Stress the point that this is the procedure that government grain graders use.

14. Grain Sample Chart and Physical Grading of Grains
    The instructor should put out 10 representative samples of wheat, corn and sorghum and the students should officially grade them with the use of the lab equipment that is recommended for this class.

CROP SEED IDENTIFICATION

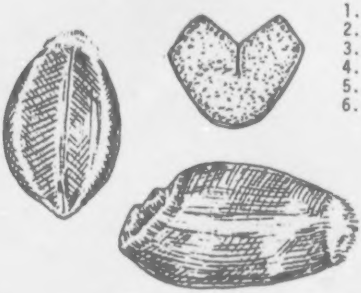
1. Hard red winter wheat



Kernel Characteristics

1. Long, narrow kernel
2. Rounded cheeks
3. Very short brush
4. Small germ
5. Usually dark brown color
6. Hard vitreous kernels

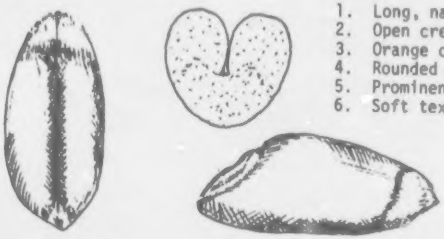
2. Hard red spring wheat



Kernel Characteristics

1. Short, plump kernel
2. Angular cheeks
3. Prominent brush
4. Large germ
5. Usually dark brown or maroon color
6. Hard vitreous kernels

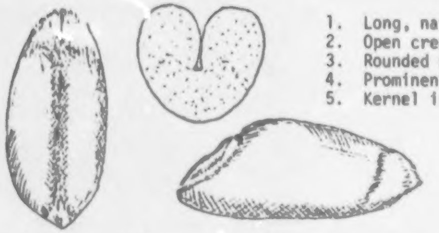
3. Soft red winter wheat



Kernel Characteristics

1. Long, narrow kernel
2. Open crease
3. Orange color
4. Rounded cheeks
5. Prominent brush
6. Soft textured kernels

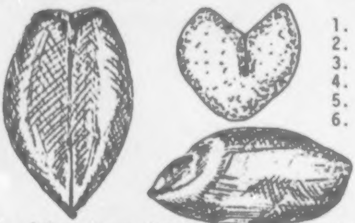
4. White wheat



Kernel Characteristics

1. Long, narrow kernel
2. Open crease
3. Rounded cheeks
4. Prominent brush
5. Kernel is white and starchy

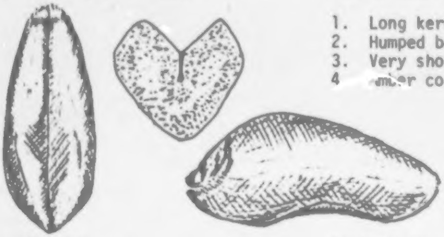
5. Red durum wheat



Kernel Characteristics

1. Brush end squared off
2. Pointed germ
3. Angular cheeks
4. Humped back
5. Dark brown or maroon in color
6. Germ protruding

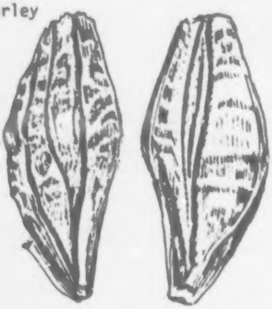
6. Amber durum wheat



Kernel Characteristics

1. Long kernel
2. Humped back
3. Very short brush
4. Amber color and translucent

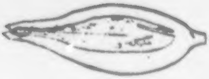
7. Barley



Kernel Characteristics

1. One-third of kernels are larger and are straight when viewed from crease side
2. Two-thirds of kernels are smaller and have a curve at the attachment end
3. white color
4. Pointed at both ends
5. Exterior distinctly ridged.

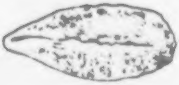
8. Oats



Kernel Characteristics

1. White, yellow or light-gray in color
2. Seeds oval shaped and smooth, ridged on back with distinct veins
3. About 1/2" long and 3/16" wide
4. Winter or summer annual grain crop

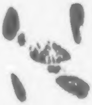
9. Rye



Kernel Characteristics

1. Greenish brown in color
2. Seeds are elongated with a shallow crease
3. Seeds are 1/4" to 3/8" long and 3/16" wide
4. Winter annual used for green manure or grain

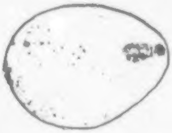
10. Sunflower



Kernel Characteristics

1. Gray to brown to black in color
2. About 1/2" wide and 3/8" long
3. Akene
4. Ovate to wedge shape

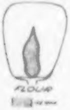
11. Sorghum



Kernel Characteristics

1. Sorghum seeds are white, red or black in color
2. Glossy outer hull
3. Shape is ovate or round
4. About 1/8" in diameter
5. Annual used for forage or grain

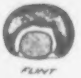
12. White or Flour Corn



Kernel Characteristics

1. Kernels composed entirely of soft starch
2. All colors, white and blue most common
3. Shaped like flint kernels

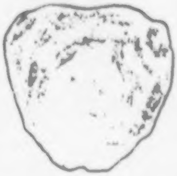
13. Flint corn



Kernel Characteristics

1. Vitreous
2. Endosperm soft and starchy around germ
3. Starchy area enclosed by very hard layer
4. Kernels rounded but sometimes are short and flat
5. Mainly white and yellow in color

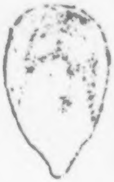
14. Sweet corn



Kernel Characteristics

1. Yellow or white colored
2. Seeds shriveled and sunken in appearance
3. Wedge-shaped, about 1/2" long and 3/8" wide
4. Used in green stage (milk) for human consumption

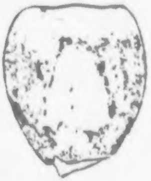
15. Pop corn

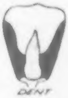


Kernel Characteristics

1. Color may be white, yellow or red
2. Seeds smooth, oval shaped and pointed
3. About 3/8" long and 3/16" wide
4. Used as confection

16. Dent corn

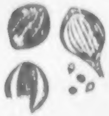




Kernel Characteristics

1. Color mostly yellow, may be white and sometimes red
2. Seeds are smooth, wedge-shaped, flat, and dented
3. About 5/8" long and 3/8" wide

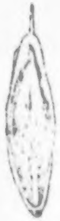
17. Foxtail Millet



Kernel Characteristics

1. Small, slick, plump seed
2. 2-3 mm in length
3. 1-2 mm in width
4. Yellow in color
5. Ovate in outline

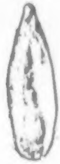
18. Bromegrass



Kernel Characteristics

1. Seeds elongated, flattened, having a chaffy appearance, with a slender rachilla
2. Color is light brown with darker streaks
3. 1/4" to 3/8" in length

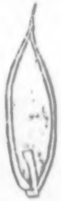
19. Bluegrass



Kernel Characteristics

1. Seeds elongated, broadest at center with a triangular cross-section and a slender rachilla
2. Distinct ridge on each side
3. Light brown in color and dull
4. 1/16" in size

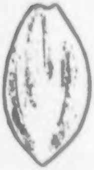
20. Orchardgrass



Kernel Characteristics

1. Seeds are slender, back of seed is curved with a curved awn
2. Seeds light yellow to gray-yellow in color
3. 1/4" in length
4. Used for pasture

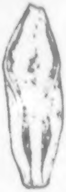
21. Timothy



Kernel Characteristics

1. Seeds are almost football shaped
2. Outer hulls are white to ivory with a lustrous appearance
3. Inner hulls are gray in appearance
4. Size is about 1/16" length

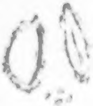
22. Ryegrass



Kernel Characteristics

1. Upper third of seed is flattened
2. Rachilla is short, thick and wedge-shaped
3. Color is light tan
4. Size is about 3/16" in length

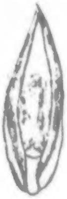
23. Bermudagrass



Kernel Characteristics

1. Seed is very small, three-sided and boat shaped
2. No rachilla
3. Straw like in color

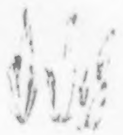
24. Tall Fescue



Kernel Characterisitics

1. Elongated seed
2. Rachilla is cylindrical, slender with a knob on the end
3. Color is light tan
4. Size is about 1/4" in length

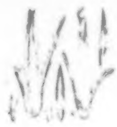
25. Big Bluestem



Kernel Characteristics

1. Usually raceme broken up with rachis joint extending about half way along one side of lower spikelet
2. Pedicel along the other side about the same distance

26. Little Bluestem



Kernel Characteristics

1. Similar to Big Bluestem
2. Smaller and shorter awn
3. Rachis joint extends about halfway along the sessile spikelet
4. Pedicel is somewhat longer, more slender and the sterile spikelet often persists

27. Switch grass

Kernel Characteristics

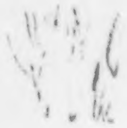
1. Smooth and shiny
2. Narrowly ovate
3. Margins of the lemma enrolled only at base

28. Sideoats grama

Kernel Characteristics

1. Seed is the short spikes as stripped from the main axis
2. 5 to 8 spikelets
3. Each spikelet may have one fertile floret; however, only 2-4 florets per spike are ordinarily found to be sterile

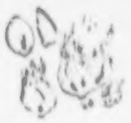
29. Blue Grama



Kernel Characteristics

1. Usually in the form of the spikelets as threshed from rachis though outer glumes may be removed
2. Nerves of lemma and palea extended as short awns
3. lemma of sterile foret has 3 awns.

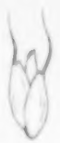
30. Buffalograss



Kernel Characteristics

1. Bur-like spike
2. Contains 4 to 5 spikelets

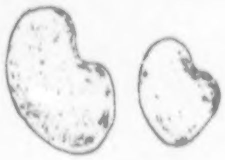
31. Indiangrass



Kernel Characteristics

1. Semi-compact spike
2. Very hairy and awned spike
3. Rich golden brown
4. Often partly sheathed

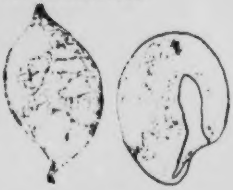
32. Alfalfa



Kernel Characteristics

1. Color will vary from ivory to light green
2. Shape will vary from kidney shaped to mitten shaped
3. Seeds are slightly lustrous
4. Size is about 1/16"

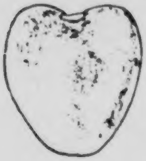
33. Sweetclover



Kernel Characteristics

1. The unhulled sweetclover is gray to tan in color
2. Unhulled is net veined and pointed on one end
3. Hulled seeds are mitten shape
4. Hulled are light ivory to greenish colored and lustrous
5. Size is 1/16"

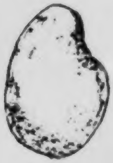
34. White clover



Kernel Characteristics

1. Seeds are mitten shaped to heart shaped
2. Seeds are lustrous
3. Size is about 1/32"

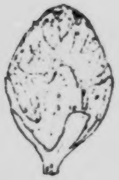
35. Red clover



Kernel Characteristics

1. Seeds are mitten shaped and heart shaped
2. Color varies from yellow to slight greenish to purple
3. Seeds are lustrous
4. They are larger than the seeds of white or alsike clover
5. Size is about 1/16"

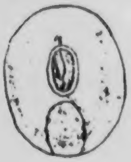
36. Korean Lespedeze



Kernel Characteristics

1. Commonly hulls are attached
2. Seeds are gray-brown in color
3. Blunt, not pointed like common lespedeze
4. Hulled seeds are maroon to black and lustrous
5. Hulled seeds are almost round and flat
6. About 1/16" in size, hulled seeds slightly smaller

37. Soybeans



Kernel Characteristics

1. Most are yellow in color, some are brown or black
2. Hilum (seed scar) may be the same color, or it may be black, gray, or brown
3. Seeds are rounded in shape
4. About 1/4" in diameter

38. Hairy vetch

Kernel Characteristics

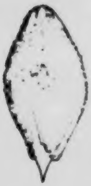
1. Seeds are dull black in color
2. Hilum marking is light colored and is long and narrow
3. Seeds are spherical shaped
4. Seeds of hairy vetch may be confused with seeds of wild mustard and rape; hairy vetch seeds are 3 to 4 times larger than rape (rape seeds are larger than mustard)
4. Hairy vetch seeds are 1/8" in diameter

39. Sumac Sorgo

Kernel Characteristics

1. Black to reddish brown in color
2. Thinly pubescent and small
3. Elliptic to ovate
4. Resembles sumac berries

40. Sudangrass



Kernel Characteristics

1. Small brown crayopsos is usually enclosed completely by straw-colored outer glumes
2. Larger than Johnson grass
3. Rachilla not knobbed as Johnson grass

41. Kansas Orange Sorgo

Kernel Characteristics

1. Glumes thinly pubescent
2. Reddish-brown to black in color
3. Lemmas not awned
4. Kernels somewhat exposed in angles and extending to or beyond the ends of the glumes.
5. Most kernels reddish-brown and thresh free of glumes

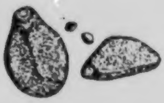
42. Hegari

Kernel Characteristics

1. Seed in grape-like clusters
2. White seed with reddish to black spots
3. Red, purple or bluish undercoat

WEED SEED IDENTIFICATION

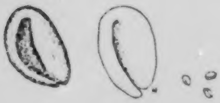
1. **Field bindweed**



Kernel Characteristics

1. Seed is flattened on one side
2. Two sides are rounded which gives the seed a shape similar to an orange section
3. Dark brownish gray in color
4. Seed coat is dull with a roughened appearance
5. Size about 1/8"

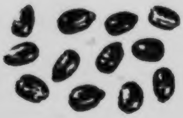
2. **Hoary Cress**



Kernel Characteristics

1. Slightly flattened
2. Egg shaped
3. Rough reddish brown surface
4. Small crease extending upward from the small end of the seed

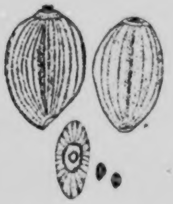
3. **Leafy Spurge**



Kernel Characteristics

1. Oval in shape
2. Smooth in texture
3. Light gray to dark brown in color with dark line on one side and yellowish appendage at point of attachment

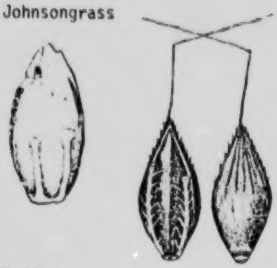
4. **Russian Knapweed**



Kernel Characteristics

1. Achenes
2. Somewhat flattened
3. Oval in shape
4. Ivory to light brown to gray in color
5. Straited

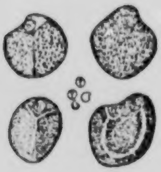
5. Johnsongrass



Kernel Characteristics

1. Seeds are rounded at base and pointed at other end
2. It has a awn that is easily broken
3. Rachilla extends almost 3/4 the length and is club shaped at the end
4. Color is black to ivory and is lustrous
5. Size is about 1/8" in length

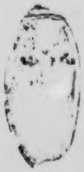
6. Dodder



Kernel Characteristics

1. Shape is globular or angular with one or more flat surfaces
2. Color is gray to grayish-yellow with a roughened seed coat
3. About 1/32" in diameter

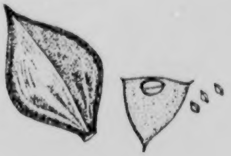
7. Canada thistle



Kernel Characteristics

1. Seeds are banana shaped
2. At the apex are cup shaped with a tubercle in the center
3. Color is light to dark brown and they have a slight lustre

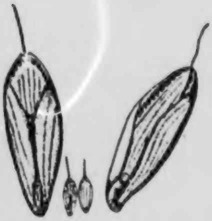
8. Curly dock



Kernel Characteristics

1. Seeds are three-angled and sharp edged
2. With hull the seed is surrounded by three heart shaped bracts
3. Color is bright brown, hulled seeds have a lustrous appearance
4. Size is about 1/16"

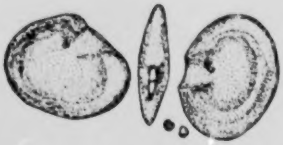
9. Cheat



Kernel Characteristics

1. Seeds are deep boat-shaped with enrolled margins
2. Seeds are normally awnless if the awn is present it is 1/8" to 1/4" in length
3. Color is yellow-gray
4. About 3/8" in length

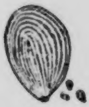
10. Horsenettle



Kernel Characteristics

1. Seeds are oval shaped
2. Seeds are flattened
3. Finely granular
4. Yellow to light brown in color

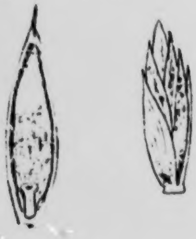
11. Pennycress



Kernel Characteristics

1. Seeds are flattened egg-shaped
2. Concentric ridges are located on either side
3. Dark reddish-brown to black in color

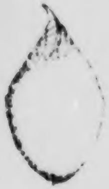
12. Quackgrass



Kernel Characteristics

1. Seeds are elongated
2. Flattened and have a short awn that is easily broken
3. May remain attached to the rachis and thus will be in a spikelet
4. Color is light tan
5. Size is about 5/16" in length

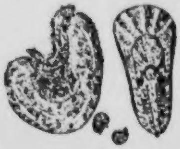
13. Wild buckwheat



Kernel Characteristics

1. Shape is three angled
2. Color is a lustrous black and are sometimes covered with a dull brown hull
3. Size is about 3/16" in length

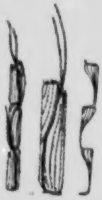
14. Velvetleaf



Kernel Characteristics

1. Seeds are flat and heart-shaped
2. Color is a mottled grayish-brown
3. About 1/8" in diameter

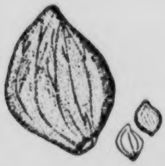
15. Goatgrass



Kernel Characteristics

1. Fruit a caryopsis, ripening ahead of the ripening wheat
2. Spike disjoints

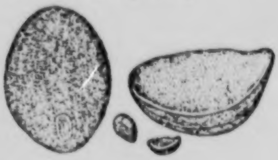
16. Wild onion



Kernel Characteristics

1. Larger than wild garlic
2. Bulblets are flat on one side
3. Crushed bulblets reveal a black seed, flat on one side
4. 1/8" in diameter

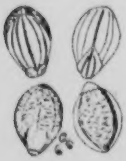
17. Annual Morning Glory



Kernel Characteristics

1. Brownish-black in color
2. Granular
3. Minutely hairy except hilum
4. Hilum black in color

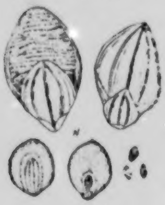
18. Green foxtail



Kernel Characteristics

1. Seeds are football shaped, slightly ridged and are more pointed on one end than the other
2. If the hull is present it covers the entire seed
3. Color is gray to grayish green and they have a dull appearance
4. Seed are about 1/16" long

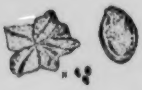
19. Yellow foxtail



Kernel Characteristics

1. Shape is oval, plane on one side and convex on the other
2. Outer papery hull on back covers only the lower half of seed
3. Color is yellow light brown
4. About 1/8" in length

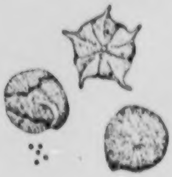
20. Kochia



Kernel Characteristics

1. Flattened, egg-shaped with a groove on each side from the narrow end
2. Surface full, granular
3. Brown in color
4. Calyx forming wing-like appendage unless threshed off

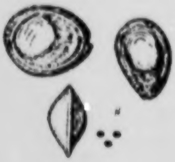
21. Lambsquarter



Kernel Characteristics

1. Seeds are double convex (lens) shaped with notched margin
2. Hulled seeds glossy to dull black
3. May have light green hull attached
4. About 1/16" in diameter

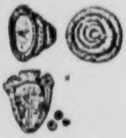
22. Redroot pigweed



Kernel Characteristics

1. Seeds are elliptical shaped and double convex (lens) shaped with a slight notch at one end
2. Color is jet black and very glossy
3. About 1/32" in diameter

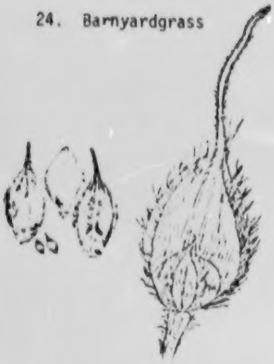
23. Russian Thistle



Kernel Characteristics

1. Fruit conical, snail-shaped
2. Seed gray to gellowish brown
3. Dull in appearance
4. Granular with spirally coiled embryo and no endosperm

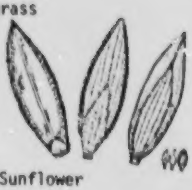
24. Barnyardgrass



Kernel Characteristics

1. Seeds have a rounded back and flat bottom
2. Outer hull is removed the seeds are hard shiny and smooth
3. Outer hulls of the seed are papery and frequently are covered with bristles
4. Often tipped with an awn
5. Color will vary from tan to brown
6. About 3/16" long

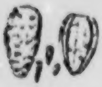
25. Crabgrass



Kernel Characteristics

1. Seed long in length
2. Hairy with one small outer glume
3. Purple during growth
4. Straw color upon maturity

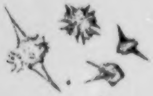
26. Wild Sunflower



Kernel Characteristics

1. Akene
2. Ovate to wedge shape
3. Gray or brown with lighter stripes or mottling
4. Much smaller in size than the common sunflower

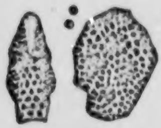
27. Puncture Vine



Kernel Characteristics

1. Borne in clusters of carpels
2. Bony with two divergent stout horns
3. Horns separate at maturity

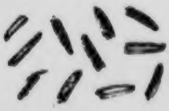
28. Buffalo Bur



Kernel Characteristics

1. Nearly circular in outline
2. Dull brownish black
3. Flattened, wrinkled and coarsely pitted

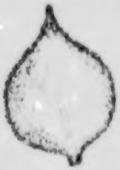
29. Western ironweed



Kernel Characteristics

1. Ribbed akene about 4 mm. long
2. Seeds tipped in a parachute of capillary bristles
3. Bristles usually lost in threshing

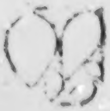
30. **Red sorrel**



Kernel Characteristics

1. Three angled seeds
2. Color is reddish-brown with a dull scaly appearance
3. If seed covering is removed they are lustrous in appearance
4. Size is about 1/32"

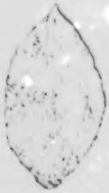
31. **Wild garlic**



Kernel Characteristics

1. Produces aerial bulblets
2. Bulblets are flat on one side
3. Color is pearly white to pinkish-tan
4. About 1/4" long, about the same size as a wheat kernel

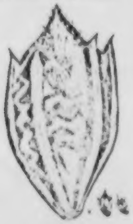
32. **Giant Foxtail**



Kernel Characteristics

1. Seeds are similar in shape to those of green foxtail
2. One exception is if the hull is present it covers about 4/5 of the seed
3. Color is gray to grayish-green with a dull appearance
4. About 3/16" in length

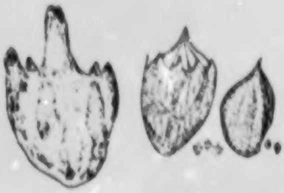
33. **Giant ragweed**



Kernel Characteristics

1. Seeds have a woody like hull
2. Blunt ridges and several thick
3. Blunt spines at one end with a central conspicuous break
4. Color is light gray to tan
5. Length is about 5/16"

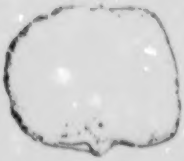
34. Common ragweed



Kernel Characteristics

1. Seeds are roughly ovate at the broader end, with several short spines and a thicker central spine
2. They have blunt longitudinal ridges
3. Color is light brown
4. About 1/8" in length

35. Jimsonweed



Kernel Characteristics

1. Kidney shaped to irregular shaped
2. Flattened with the seed coat rougn being covered with small pits
3. Color is usually black but may be gray
4. Length is about 1/4"

GRAIN GRADING DEFINITIONS

FULLY DEFINE THESE TERMS:

1. Wheat-
2. Dockage in Wheat-
3. Foreign Material in Wheat-
4. Other Grains-
5. Damaged Kernels-
6. Heat-Damaged Kernels in Wheat-
7. Contrasting Classes of Wheat-
8. Shrunken and Broken Kernels of Wheat-
9. Stones-
10. Defects-
11. Dark Hard Winter Wheat-
12. Hard Winter Wheat-
13. Yellow Hard Winter Wheat-
14. Tough Wheat-
15. Smutty Wheat-

16. Garlicky Wheat-

17. Weevily Wheat-

18. Ergoty Wheat-

19. Treated Wheat-

20. Corn-

21. Yellow Corn-

22. White Corn-

23. Mixed Corn-

24. Broken Corn and Foreign Material-

25. Damaged Kernels-

26. Heat-Damaged Kernels-

27. Weevily Corn-

28. "Distinctly Low Quality"-

29. Sorghum-

30. Broken Kernels, Foreign Material and Other Grains-

31. Brown Sorghum-

32. White Sorghum-

33. Yellow Sorghum-

34. Mixed Sorghum-

35. Total Damaged Kernels-

36. Distinctly Low Quality-

37. Dockage-

38. Heat-Damaged Kernels-

39. Nongrain Sorghum-

40. Other Grains-

41. Pericarp-

42. Smutty Sorghum-

43. Weevily Sorghum-

44. Test Weight -

45. Moisture Testor -

46. Grain Probe -

WHEAT GRADING QUESTIONS

1. A sample of Hard Red Winter Wheat that contains 2% total damage, 0.5% foreign material, 3% shrunken and broken, would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( ) No. 5( ) Sample( )
2. The class Hard Red Winter is divided into how many grades? 4( ) 5( ) 6( )
3. "Dockage" in wheat standards is: Extra Pounds Per Bushel( ) Material removed by appropriate sleeves( )
4. How much dockage would an inspector assess if he found 15 grams of dockage in 1,000 grams of wheat? ____________________
5. Would rye normally be included in dockage? Yes( ) No( )
6. Hard Red Winter containing 2.5% foreign material would grade: No 1( ) No. 2( ) No.3( ) No. 4( )
7. The official test weight per bushel kettle has a capacity of: 1 Pint( ) 1 Quart( ) 2 Quarts( ) 1 Gallon( )
8. Hard Red Winter weighing 57.5 lbs. per bushel (otherwise No. 1) would grade: No. 2( ) No. 3( ) No. 4( ) No. 5( )
9. Would a sample with 90% Hard Red Winter and 10% Soft Red Winter grade in the mixed class? Yes( ) No( )
10. Would the above sample grade: No. 1( ) No. 2( ) No. 3( )
11. What numerical grade would apply to a sample of Hard Red Winter containing 2% Durum Wheat? No. 1( ) No. 2( ) No. 3( )
12. Check subclass of Hard Red Winter containing 39% dark, hard, and vitreous kernels: Dark Hard Winter( ) Hard Winter( ) Yellow Hard Winter( )
13. Check the kinds of damage to wheat which occur in the field: Frosted( ) Black Germ( ) Heat Damage( ) Weevil-Bored( ) Moldy( ) Scab( ) Sprouted( )
14. Hard Red Winter Wheat continaing 7% of total damaged kernels, consisting of 1.0% heat damaged and 6.0% weevil-bored kernels, would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( ) No. 5( )
15. Hard Red Winter will grade tough if the moisture content is: 12.0%( ) 13.0%( ) 13.5%( ) 14.0%( ) 14.5%( ) 15.0%( ) 15.5%( ) 16.0%( )

16. Is special grade "Weevily" applied when two live weevils are found in 1,000 grams of wheat? Yes( ) No( )

17. How would you grade a sample consisting of 89% wheat and 11.0% rye?

____

____

18. Hard Red Winter Wheat, weighing 60 lbs., containing 9% shrunken and/or broken kernels, would grade: No. 1( ) No. 2( ) No. 3( ) No. 4(

19. Hard Red Winter Wheat, which is musty, would grade: No. 4( ) No. 5(Sample Grade ( )

20. Wheat grading No. 4 may contain 12% of Black Germ Damage: Yes( ) No( )

21. A sample of wheat that contains 5% shrunken and broken kernels, 2% total damage, and 1% foreign material, would grade: No. 3( ) No. 4(No. 5( )

22. A sample of wheat that contains 1% total damage, 0.5% foreign material, and 2% shrunken and broken, would grade: No. 1( ) No. 2( ) No. 3( )

23. A sample containing 95% Hard Red Winter and 5% Hard Red Spring, testing 61 lbs., would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( ) No. 5( )

24. A sample containing 6% shrunken and broken, 3% total damage, testing 60 lbs., would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( ) No. 5( )

25. A sample containing 1% total damage, 0.5% foreign material, and 2% shrunken and broken, would grade: No. 1( ) No. 2( ) No. 3( )

26. Wheat is divided into how many grades? 4( ) 5( ) 6( )

27. How much dockage would an inspector assess if he found 16 grams of dockage in 1,000 grams of wheat? ___________________________

28. Hard Red or Soft Red Winter Wheat containing 1.5% foreign material (otherwise No. 1) would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( )

29. Hard Red or Soft Red Winter Wheat weighing 57.7 lbs. per bushel (otherwise No. 1) would grade: No. 2( ) No. 3( ) No. 4( ) No. 5( )

30. Would a sample with 85% Hard Red Winter Wheat and 15% Soft Red Winter Wheat grade in the Mixed class? Yes( ) No.( )

31. Would the sample in No. 30 grade: No. 1( ) No. 2( ) No. 3( )

32. What numerical grade would apply to a sample of Hard Red Winter or Soft Red Winter Wheat containing 2% Durum Wheat? No. 1( ) No. 2( ) No. 3( )

33. The subclass of Hard Red Winter Wheat containing 65% dark, hard, and vitreous kernels is: Dark Hard Winter( ) Hard Winter( ) Yellow Hard Winter( )

34. Wheat containing 3% of total damaged kernels, consisting of 4.0% heat damaged and 6.0% weevil-bored kernels, would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( ) No. 5( )

35. How would you grade a sample consisting of 99% of wheat and 1.0% of rye? ______________________________

36. Hard Red or Soft Red Winter Wheat weighing 60 lbs., containing 4% shrunken and broken kernels (otherwise No. 1) would grade: No. 1( ) No. 2( ) No. 3( ) No. 4( )

37. Wheat grading No. 4 may contain 16% of Black Germ Damage: Yes( ) No( )

38. Defects in wheat standards shall include damaged kernels, foreign material, and shrunken and broken kernels. Yes( ) No( )

39. Is special grade "Heavy" applied to wheat grading No. 4 Yes( ) No( )

40. Wheat of the Class White Wheat is considered a contrasting class when found in class:
    Hard Red Winter Wheat Yes( ) No( )
    Soft Red Winter Wheat Yes( ) No( )

41. A sample of wheat containing 1.5% damaged kernels, 0.5% foreign material 4% Total Def. and 2.0% shrunken and broken kernels would grade No. 1( ) No. 2( ) No. 3( ) No. 4( ) No. 5( )

WHEAT GRADING EXERCISE

#1 HRW Wheat 81% dhvk

Moisture ------------------12.0
Test weight ---------------62.0
Heat damage --------------- 0.1
Black germ of wheat ------- 1.0

Sunflower -------------------0.4
Broken kernels --------------1.0
Club wheat ------------------0.7
Durum wheat -----------------0.5

Complete grade and designation	Factor or factors

#2 HRS Wheat 65% dhvk

Moisture ------------------13.7
Test weight ---------------57.0
Heat damage --------------- 0.3

Weather damage --------------2.0
Rough pigweed ---------------0.6
Shrunken kernels ------------2.0
Durum wheat -----------------1.0

Complete grade and designation	Factor or factors

#3 HRW Wheat 72% dhvk

Moisture ------------------13.4
Test weight ---------------58.0
Heat damage --------------- 0.3

Oats ------------------------0.4
Shrunken and broken kernels--2.0
Durum wheat -----------------1.0
Odor ------------------------Smutty

Complete grade and designation	Factor or factors

#4 HRW Wheat 65% dhvk

Moisture ------------------13.7
Test weight ---------------61.0
Heat damage --------------- 0.3

Black germ ------------------1.5
Foreign material ------------0.2
Shrunken and broken kernels--3.0
Durum wheat -----------------4.0

Complete grade and designation	Factor or factors

#5 SRW Wheat

Moisture -----------------13.7
Test weight ---------------61.0
Heat damage --------------- 0.3
Black germ ---------------- 1.5

Foreign material -------------0.2
Shrunken and broken kernels---3.0
Durum wheat ------------------1.0
32 smut balls in 500 grams

Complete grade and designation	Factor or factors

#6 HRS Wheat 61% dhvk

Moisture -----------------12.2
Test weight ---------------54.0
Heat damage --------------- 0.2

Black germ -------------------0.1
Foreign material -------------2.0
Ergot ------------------------0.4
Dockage ----------------------1.6

Complete grade and designation	Factor or factors

#7 HRW Wheat 78% dhvk

Moisture -----------------14.0
Test weight ---------------56.0
Damaged kernels ----------- 2.0

Oats -------------------------0.4
White wheat ------------------1.0
3 green garlic bulblets in
1,000 grams

Complete grade and designation	Factor or factors

#8 HRS Wheat 98% dhvk

Moisture -----------------14.1
Test weight ---------------59.0
Shrunken and broken kernels-2.0

3 live weevils
8 green garlic bulblets in 1,000 grams
Dockage ----------------------7.0

Complete grade and designation	Factor or factors

#9 SRW Wheat

Moisture ------------------13.8
Test weight ---------------55.0
Heat damage --------------- 0.9
Foreign material ---------- 2.5

1 dead weevil
45 smut balls in 250 grams
4 green garlic bulblets in 500 grams
Ergot --------------------- 0.5

Complete grade and designation	Factor or factors

#10 HRW Wheat 35% dhvk

Moisture ------------------13.5
Test weight ---------------55.0
Damage --------------------1.0%
Foreign material ----------0.4

Odor ----------------------Smutty
Dockage -------------------2.3
Ergot ---------------------0.2
6 live weevils

Complete grade and designation	Factor or factors

#11 HRW Wheat 78% dhvk

Moisture ------------------13.5
Test weight ---------------62.1
Odor ----------------------Smutty
Contrasting classes -------7.5
Total wheats of other classes ------------------8.0

Weevil damage -------------3.8%
Heat damage ---------------0.6
Rye -----------------------1.0
Shrunken and broken kernels-3.5
Dockage -------------------0.9

Complete grade and designation	Factor or factors

#12 Wheat 55% dhvk

Moisture ------------------15.8
Test weight ---------------58.0
Odor ----------------------Natural
Durum wheat ---------------3.0

Total wheats of other classes ------------------5.0
Sprout damage -------------5.0%
Flax ----------------------2.0%
Shrunken and broken kernels-9.0
Dockage -------------------1.9

Complete grade and designation	Factor or factors

#13 HRW Wheat 22% dhvk

Moisture --------------------14.2
Test weight -----------------59.0
Weevil damage ---------------4.0
Heat damage -----------------0.2

Sunflower -------------------1.0
Shrunken and broken kernels--5.0
White wheat -----------------4.3
1 live weevil in 50 grams
15 smut balls in 250 grams
Dockage ---------------------1.4

Complete grade and designation	Factor or factors

#14 HRS Wheat 46% dhvk

Moisture --------------------12.5
Test weight -----------------59.0
Insect damage --------------- 3.0

Rice ------------------------0.7
Contrasting classes----------1.2
14 smut balls in 500 grams
1 garlic bulblet in 1,000 grams
3 live weevils

Complete grade and designation	Factor or factors

PROCEDURES FOR OFFICIALLY GRADING WHEAT

PROBLEM: How do we establish the official grade for wheat? What procedures do we follow in obtaining the sample? What factors are used in determining a proper grade?

EQUIPMENT: Sampling probe (segmented preferred); Boerner divider; small pans for samples; moisture tester and thermometer; balance scales; tweezers; appropriate sieves, screens and pans (12/64 and 5/64 inch sieve, and 3/8 X .064 inch oval hole sieve); filling hopper; and weight per bushel kettle and beam with a strike-off stick.

REFERENCES: Official Grain Standards of the United States, C&MS-177, USDA, Hyattsville, Maryland.
Kansas State University Extension Service, Leaflet L-19, Manhattan, Kansas.

SEQUENCE OF STEPS	EXPLANATION OF PROCEDURE
STEP 1	Obtain a representative sample.
	A) Use a trier (probe) measuring 63 inches long with 10 openings for railroad cars. Use a 40 inch trier with 6 openings for trucks.
	B) Insert the probe to its full depth at a 10 degree angle from vertical in closed position.
	C) Open the ports on the probe after insertion into the grain, and move slightly up and down twice to fill the probe. Close the ports and remove the sample.
	D) A representative sample may vary; but for the State Grain Lab, a minimum of 5 probes are taken --giving them a total weight of approximately 5 pounds.
	E) When sampling a load, observe for any stones too large to enter the probe. If any are present, the wheat will grade "Sample".
	F) A minimum of 1,000 grams must be obtained to determine the official grade.

SEQUENCE OF STEPS	EXPLANATION OF PROCEDURE
STEP 2	Check the sample for odors by smelling.

A) If foreign odors are present in the grain, it will cause a grade determination of "Sample".

B) Possible odors: musty, sour, petroleum, creosote, smoke, fireburnt, insect, skunk, fertilizers, or any other objectionable odor.

C) All objectionable odors must be reported to the Pure Food and Drug Administration for actual determination, and to see if the load can be salvaged.

STEP 3 — Make a visual check for Distinct Low Quality, Weevily, and Garlicky.

A) If a garlic smell was noted in the previous step, make a visual check for garlic bulbs. The wheat may be graded Garlicky if:
   1) Two green bulbs per 1,000 gram sample
   2) Six dry bulbs per 1,000 gram sample
   3) Generally found in Soft Red Winter Wheat areas.

B) Rodent excreta or bird excreta:
   1) If found, sample will be given a notation of D.L.Q. (Distinct Low Quality).
   2) All excreta notations are reported to the Pure Food and Drug Administration.

C) Treated "Pink Wheat" is no longer noted D.L.Q.
   1) All "Pink Wheat" will be comdemned.
   2) Must be disposed of by burying
   3) All expenses insurred during the process of condemning and burying are those of the owner.

STEP 4 — Make a visual check for Mixed grain.

A) If other grains are noticeable in the sample, a weight and count determination must be made.

B) If 10% or more by weight of other grains is in the sample, then the wheat is given a grade notation of "Mixed".

C) Other grains: oats, rye, barley, grain sorghum, corn, and soybeans.

D) Approximately a 60 gram sample is divided out on the Boerner divider and hand picked to remove all of the other grains. The removed grain is then weighed and a percentage is calculated.

STEP 5 Determine the moisture content of the grain.

A) Several machines are in use today manufactured by different companies; however, most machines require a 250 gram sample. The moisture will be a direct reading from the machine.*

B) First, take a temperature reading on the grain to determine the correction factor. Charts are provided with each moisture tester to obtain the correction factor.

*C) Add or substract the moisture correction factor to the machine's reading of the moisture content.

D) Record the official moisture content of the grain.

STEP 6 Making the dockage test.

A) Dockage definition: Dockage includes weed seeds, stems, chaff, straw, grain other than wheat, sand, dirt, and any other material that can be removed by appropriate sieves or cleaning devices.
   1) Dockage does not affect the grade of the wheat.
   2) Dockage is a weight deduction factor, removed before grading.
   3) Dockage is figured as a percentage.
   4) Dockage is recorded in 0.5% divisions.
      ie. on the half percent and whole percent. Any percentage below 0.5% is recorded as 0%.

B) Begin with a representative sample weighed to 1,000 grams.

C) Run the sample through a dockage kicker or use the following hand sieves.
   1) Use two sieves and a pan to determine dockage.
   2) Top sieve is coarse-round holes 12/64 inch in diameter.
   3) Middle sieve is fine-round holes 5/64 inch in diameter.*
   4) A pan is placed on the bottom to catch the fine dockage.
   *5) In case of excessive buckwheat, use a "buckwheat" sieve--triangle holes of 5/64 in place of the fine dockage sieve.

D) Add the fine screenings and material retained on the course sieve together to determine the dockage weight.
   1) Wheat is hand picked from the dockage material and added back to the screened sample.
   2) Other grain is picked out of the sieve sample and added to the dockage screenings before weight determination of the dockage.

E) Compute the dockage as a percentage.
   1) Divide the original weight of the sample into the weight of the dockage screenings, and multiply by 100.
   2) If 6 grams of dockage is in a 1,000 gram sample, the result would be 0.6% dock.

F) Officially record the docakge in even 0.5% breaks. ie. 0.9% dock would be noted as 0.5%, 0.4% would be noted as 0% dock, and 1.2% dock would be 1.0%.

STEP 7 Determining weight per bushel (test weight).

A) A dockage free sample is used to determine test weight.

B) Use the correct equipment for determination.
   1) Place the filling hopper and stand on a firm level surface.
   2) The filling hopper should be large enough to hold the total 1,000 gram sample and have a 1-1/4 inch opening at the bottom.
   3) Use a one quart weight per bushel kettle with a balance weight beam.
   4) The one quart kettle has a 4 inch depth and a capacity of 67.2 cubic inches.
   5) Use the strike-off stick to level the grain in the kettle.
   6) The strike-off stick should measure 12 inches long, 1-3/4 inches wide, 3/8 inches thick, and should have half round edges free of any dents or defects.

C) Use the equipment properly.
   1) The filling hopper must be level when used.
   2) The bottom of the filling hopper must be exactly 2 inches above the top of the kettle.
   3) Open the filling hopper and allow the entire volume of grain to flow out, then remove hopper.

4) After filling, strike-off the kettle with the strike-off stick. Strike-off the kettle ONLY ONCE using a zigazg motion with 3 strokes.
5) Hang the kettle on the beam and weigh the sample.
6) Record the official test weight of the grain.

STEP 8 Using the Boerner divider, split down the dockage free sample into the following approximate measures.

A) 250 grams used to determine shrunken and broken.

B) 60 grams used to determine foreign material.

C) 15 grams used to determine total damage.

STEP 9 Determination of foreigh material (F.M.).

A) Use the 60 gram dockage free sample previously divided and remove all F.M. by hand picking.

B) Foreign material cannot be removed by dockage sieve. Foreign material can lower the official grade and lowers the value of the wheat for milling.

C) F.M. is all matter other than wheat which was not separated during the dockage test.

D) Small inseparable stones found during this procedure requires that the entire 1,000 gram sample be hand picked for the stones. If 8 or more stores are found, the wheat is graded "Sample".

E) Weigh the hand picked portion removed from the 60 gram sample.

F) Compute the F.M. as a percentage and record.

G) A F.M. percentage greater than 0.5% will lower the grade from Number 1 wheat to Number 2, a percentage greater than 1.0% will lower Number 2 wheat to Number 3, etc.

STEP 10 Assessing shrunken and broken.

A) Use the 250 gram sample previously divided.

B) Use a sieve with oblong holes measuring 0.064 X 3/8 inches long, and place over a pan. Pour the 250 gram sample into the sieve.

C) Shake the pan and sample from side to side 30 times (30 round trip motions).

D) Weigh the shrunken and broken material collected in the pan and figure the percentage of the 250 gram sample.

E) Record the official shrunken and broken value for the sample.

F) Any percentage greater than 3.0% will lower the grade from Number to Number 2 wheat.

STEP 11 Determine total damage.

A) Use the 15 gram sample previously divided.

B) Hand pick the entire 15 gram sample, looking for damaged kernels.

C) Check for the following kernel damage: sick wheat, heat damaged, weevil cut, sprouted, fungus, frosted, scab, and green immature kernels.

D) If heat damaged kernels are found, a percentage is figured and recorded separately for the heat damage.

E) Weigh the separated damaged kernels, determine the percentage, and record the results.

F) Any percentage greater than 2.0% will lower the wheat from Number 1 to Number 2.

STEP 12 Total defects.

A) Add the values derived previously for total damage, foreign material, and shrunken and broken to obtain the total defects percentage and record.

B) Total defects greater than 3.0% will lower Number 1 wheat to Number 2, and defects greater than 5.0% will lower Number 2 to Number 3 wheat.

C) A combination of these 3 grading factors may be sufficient to lower the grade.

STEP 13 Wheat grading notations.

A) Vitreous notations of Dark Hard, Hard, and Yellow are used to determine milling qualities and color.

B) Tough wheat is noted any time the moisture content is 13.5% or greater.

C) Heavy wheat is any wheat having a test weight of 62 pounds per bushel or greater.

STEP 14 Final determination of grade.

A) Grade may be determined by a single factor--such as damage, foreign material, or shrunken and broken.

B) Grade may be determined by a combination of factors added together to give a single value. ie. total damage.

C) The lowest grade determined by a single factor, or a combination of factors, is the highest possible grade a sample of wheat may receive.

STEP 15 Writing grade designation.

A) First, the number of the grade or the words "Sample Grade".

B) Second, the appropriate subclass should follow the grade; such as, "Dark" or "Yellow".

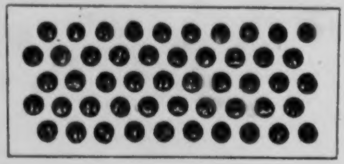
C) Third, the class of wheat will follow the subclass; such as, "Hard Red Winter Wheat".

D) Fourth, any special grade or notation should be listed. ie. Tough, Garlicky, Weevily, Heavy and D.L.Q.

E) Example: US #2 Y HWW, Tough
US #1 D HWW, Heavy
US #3 HWW, Weevily
Sample Grade--Objectionable Petroleum Odor.

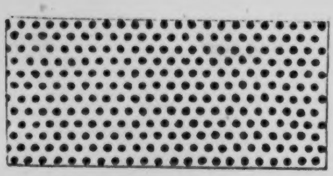
Sieves Used To Determine Dockage

Top Sieve



12/64 inch round hole used to remove coarse dockage

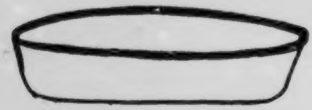
Bottom Sieve



1/12 inch round hole used to remove fine dockage.

Wheat kernels will remain on this sieve

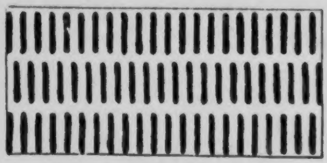
Pan On Bottom



Fine dockage collects in the pan. Add the coarse and fine dockage together to determine the total weight

Sieve Used To Determine Shrunken And Broken (Presence of Insects)

Top Sieve



.064 inch X 3/8 inch slotted sieve to remove shrunken and broken kernels. Sound kernels remain on this sieve.

Pan On Bottom

Shrunken and broken kernels collect in the pan.

Look for insects in the pan during this determination.

CORN GRADING QUESTIONS

1. Corn is divided into how many classes? 2( ) 3( ) 4( )

2. White-capped yellow kernels shall be classified as Mixed Corn.
True ( ) False ( )

3. Corn is divided into how many grades? 4( ) 5( ) 6( )

4. White Corn must be 98% White. True ( ) False ( )
Yellow Corn must be 95% Yellow. True ( ) False ( )

5. Corn standards cover both flint and dent varieties. True ( ) False ( )

6. Into what class would you place corn containing 92% Yellow and 8% White-capped Yellow kernels? ______________________________

7. Corn containing 4.5% of cracked corn and foreign material would grade: No. 3( ) No. 4( ) No. 5( )

8. A sample of corn containing 2 live weevil in 1000 grams would not grade weevily. True ( ) False ( )

9. Sweet Corn and Pop Corn in the grading of corn are considered cracked corn and foreign material. True ( ) False ( )

10. What would you grade a sample of corn containing 86.0% corn and 14.0% soybeans? ______________________________

11. Corn containing 20.8% moisture would grade: No. 3( ) No. 4( )
No. 5( )

12. Corn containing 13 stones weighing 0.17% would grade Sample Grade.
True ( ) False ( )

13. Corn containing 7% total damage and 1.0% of heat damaged soybeans would grade: No. 3( ) No. 4( ) No. 5( )

14. Corn containing 11.8% of moth cut kernels would grade No. 4: True ( )
False ( )

15. Musty Corn would grade No. 5. True ( ) False ( )

CORN GRADING EXERCISE

# 1 Corn 98W and 2Y

Test weight ------------56.5%
Moisture ---------------14.1%
Broken corn & foreign
material ---------------2.2%

Heat damage ---------------0.21%
Sprouted kernels ----------2.0%

Complete grade and designation	Factor or factors

#2 Corn 92W and 8Y

Test weight ------------56.0#
Moisture ---------------14.0%
Broken corn & foreign
material ---------------3.1%

Heat damage ----------------0.1%
Weather damage -------------5.4%
2 live weevils

Complete grade and designation	Factor or factors

#3 Corn 95Y and 5W

Test weight ------------57.0#
Moisture ---------------15.0%
Foreign material ------- 2.2%

Heat damage ----------------0.1%
Weather damage -------------5.0%

Complete grade and designation	Factor or factors

#4 Corn 93Y and 7W

Test weight ------------53.0#
Moisture ---------------16.5%
Barley ---------------- 4.2%

Heat damage ----------------0.7%
Weather damage -------------7.1%
Odor ----------------------Musty
3 live weevils

Complete grade and designation	Factor or factors

#5 Corn 94Y and 6W

Test weight ------------75.0#
Moisture ---------------16.2%
Broken corn & foreign
material --------------- 1.3%

Heat damage ---------------0.67%
Moldy kernels ------------- 7.2%
Odor ---------------------- Sour

Complete grade and designation	Factor or factors

#6 Corn 95Y and 5W

Test weight ------------47.0#
Moisture ---------------15.0%
Broken corn & foreign
material --------------- 3.2%

Heat damage ---------------1.1%
Sprout damage -------------14.0%
2 live weevils

Complete grade and designation	Factor or factors

#7 Corn 97W and 3Y

Test weight ------------55.0#
Moisture ---------------14.1%
Broken corn & foreign
material --------------- 1.6%

Heat damage ---------------0.1%
Frosted kernels -----------3.0%
6 live weevils

Complete grade and designation	Factor or factors

#8 Corn 96W and 4Y

Test weight ------------56.0#
Moisture ---------------15.4%
Broken corn & foreign
material --------------- 2.2%

Heat damage ---------------0.21%
Sprout damage ------------- 2.0%
Moldy kernels ------------- 3.0%
1 live weevil

Complete grade and designation	Factor or factors

#9 Corn 99W and 1Y

Test weight ------------52.0#
Moisture ---------------14.3%
Foreign material ------- 3.1%

Heat damage ---------------0.53%
Sprouted kernels ---------- 6.6%
3 live weevils

Complete grade and designation	Factor or factors

#10 Corn 89W and 11Y

Test weight ------------57.0#
Moisture ---------------12.5%
Foreign material ------- 4.0%

Heat damage ---------------0.1%
Odor ----------------------Natural

Complete grade and designation	Factor or factors

PROCEDURES FOR OFFICIALLY GRADING CORN

PROBLEM: How are grades officially established for corn?
What procedures are followed to obtain a sample?
What factors are used in determining a proper grade?

EQUIPMENT: Sampling probe (segmented preferred), Boerner divider, small pans for samples, moisture tester and thermometer, balance scales, tweezers and razor blade, filling hopper, weight per bushel kettle and beam with strike-off stick, and appropriate screens and sieves. (#12 screen, 12/64 round holes).

REFERENCES: Official Grain Standards of the United States, USDA, SRA-C&MS-177, Federal Building, Hyattsville, Maryland.
Kansas State University Extension Service, Leaflet L-59, Manhattan, Kansas.
Seedburo Equipment Company, 1022 W. Jackson Boulevard, Chicago 6, Illinois.
Kansas State Grain Laboratory, Hutchinson, Kansas.
FAR-MAR-CO, Inc., 400 Wiley Building, Hutchinson, Kansas.

STEP	APPROVED PRACTICE
Obtain a representative sample of corn.	1. Use a probe or trier. a. 63 inches long--Gov. probe for railroad cars. b. 40 inches long--Truck probe for local elevators. c. Use a pelican bag to catch midstream samples where necessary. 2. Take a minimum of 5 probes to insure a representative sample. a. 5 pounds are taken by State Labs. b. 1,000 grams are needed to run an official grade. 3. When sampling and probing, observe: a. The color of the corn. b. The kind of corn. Is it dent, flint or popcorn, or mixed? c. Large stones, debris and cobs. d. Foreign or objectionable odors. e. The physical shape of the load. Is it peaked or leveled out? This will give you an indication of whether the load is wet or dry.

Check the condition of the corn.

1. Smell the grain for odors.
   a. Sour, musty, fireburnt, smoke, skunk.
   b. Petroleum, creosote, fertilizer.
   c. Corn will grade "Sample" if any of the above odors are noted.
   d. All "objectional odors" must be reported to the Pure Food and Drug Administration, (by the State Lab).
2. Look for live insects in the sample.
   a. "Weevily" is added to the corn grade if live insects or weevils are seen.
   b. Look for insect damage to the corn and insect odors.
3. Observe the kernels of corn.
   a. Are the kernels plump and full?
   b. Are the kernels damaged or cracked?
   c. Are there dark or burnt kernels, or dryer damage?

Determine the moisture content of the corn.

1. Moisture is a grading factor in corn.
   a. Over 14% moisture, the grade is affected and lowered.
   b. A maximum of 15.5% moisture is allowed for #2 corn--the standard used for buying and selling.
2. Use a 250 gram sample for the rest.
   a. Split down the sample on the Boerner divider to 250 grams, OR
   b. Weigh out 250 grams on a balance scale for moisture.
   c. Enclose the 250 grams in an air-tight container or immediately complete the test. Corn will take on moisture from warm air in a room as it warms up.
3. Take a temperature reading of the corn.
   a. A correction must be made in the moisture reading for temperature.
   b. Temperature and moisture are two of the most important considerations in storage life of corn.
   c. Run the 250 gram sample through the moisture tester.
   d. Record the corrected moisture reading.

Special grades for corn

1. Weevily--is a notation given to corn infested with live weevils or any other insect that is injurious to corn.

2. Inseperable stones--"Sample Grade":
    a. When 8 or more stones are found in the sound corn free of F.M. and cracks. These stones will have to be hand picked from the test sample of corn.
    b. Dirt particles, stones and cinders having a total weight of more than 0.2% will grade "Sample".
3. Distinctly Low Quality:
    a. Rodent pellets, bird excreta or pieces of glass are found in the corn--it is marked "Sample Grade" and D.L.Q. is added.
    b. Grain receiving this notation is reported to the Pure Food and Drug Administration.
    c. Any of the items mentioned or a combination of items in excess of 0.2% by weight is given this notation.
    d. Any corn containing more than two crotalari seeds per 1,000 grams of grain will be graded as D.L.Q.

Grade designation for corn.

1. The written grade for corn shall be in the following order:
    a. First, the number of the grade OR the words "Sample Grade".
    b. Second, the name of the class.
       ie. Yellow Corn, White Corn, and Mixed Corn.
    c. Third, follow the class with any applicable special grade.
       ie. Flint, Dent, Weevily, D.L.Q.
2. Example: US Number 3 Yellow Corn, Weevily.

Run a weight per bushel test.

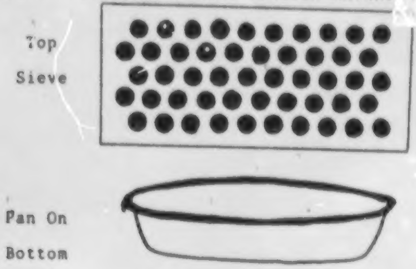
1. Place the 1,000 gram sample in a filling hopper.
2. Open the filling hopper and fill the weight/bushel kettle.
3. Carefully move the filling hopper to one side. Do not shake or vibrate the kettle, as this causes packing and settling.
4. Use the strike-off stick to level the grain in the kettle.
    a. Strike-off the kettle ONLY ONCE.
    b. Use a zigzag motion.
    c. Make 3 zigzag strokes across the kettle.
5. Place the kettle on the weighing beam and read to the nearest 1/2 pound.
6. Record the weight per bushel.

Test the corn for cracked kernels and foreign material.	1. Use the entire 1,000 gram sample. 2. Place the sample on 12/64 inch #12 sieve. a. Make 30 complete rotations by hand, OR b. Run through a docker kicker. 3. Remove by hand--all foreign material remaining on top of the hand sieve. a. Add the F.M. to the fines in the pan below the sieve and weigh. b. From a dockage kicker--add all material, other than the sound kernels of corn, together and weigh. 4. Compute the percentage. a. Any value greater than 2% will lower the grade to #2. b. Any value over 3% will grade the corn a #3. 5. Record the percentage.
Check the cleaned sample for damaged kernels.	1. Use the clean corn from the sieve, free from cracked and F.M. 2. Weigh out 250 grams and hand pick all of the damaged kernels. a. Damage may include: insect, mold, sprouted, dryer, heat, ground or cob rot. b. If heat damaged kernels are present, they are picked out separately and weighed. 3. Figure the percentage of heat damage and total damage. 4. Record the results, both total damage and head damage (if present).

HAND SIEVES FOR CORN AND MILO

CORN SIEVE

SIEVE USED TO DETERMINE FOREIGN MATERIAL

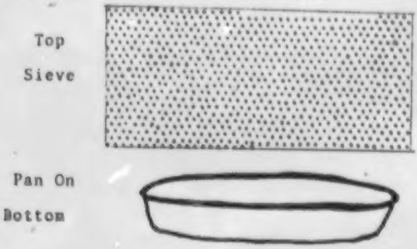


12/64 inch round holes used to remove broken kernels and foreign material.
Sound kernels remain on the sieve.

Broken kernels and foreign material collect in the pan.

GRAIN SORGHUM SIEVES

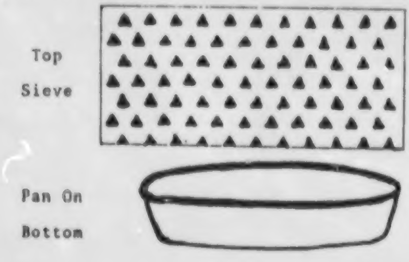
SIEVE USED TO DETERMINE DOCKAGE



2½/64 inch round holes used for removal of dockage.
Sound kernels remain on this sieve. (Use this grain for foreign material determination.

Dockage will collect in the pan.

SIEVE USED TO DETERMINE FOREIGN MATERIAL (PRESENCE OF INSECTS)

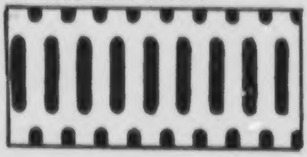


5/64 inch triangle holes. Used for removal of foreign material and broken kernels. (Use the dockage free sample previously run over the 2½/64 inch sieve.)

Foreign material and broken kernels will collect in pan. Add matter other than Grain Sorghum remaining on sieve to this material in pan. (Look for insects during this determin-

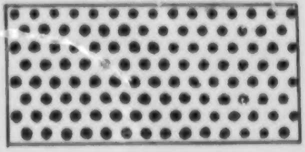
HAND SIEVES FOR SOYBEANS

SIEVE USED TO DETERMINE SPLITS



10/64 inch X 3/4 inch slotted sieve used to remove "splits". Sound soybeans will remain on this sieve

SIEVE USED TO DETERMINE FOREIGN MATERIAL



8/64 inch round hole used to determine foreign material. "Splits" will remain on this sieve.

Pan On
Bottom

Foreign material will collect in the pan. Any matter other than soybeans remaining on the sieves should be removed and added to the foreign material in the pan.

HAND SIEVES AND SCREENS

Wheat:
Set #10 grading sieves
Sieves A, B, C, F, & E -- for official grading
Sieves for country station
   12/64 in. round hole - on top
   1/12 in. round hole - in middle*
   Pan on bottom
*Sieve for buckwheat is 5/64 in. triangle
Sieve for shrunken & broken
   0.064 X 3/8 in. over pan

Corn:
Set #10 grading sieves
Sieves A, B, C, F, & E -- for official grading
Sieve for country station
   12/64 in. round hole over a pan

Grain Sorghums:
Set #9 grading sieves
Sieves K, B, & E -- for official grading
Sieves for country station
   5/64 in. triangle hole -- (buckwheat sieve)
   2½/64 in. round hole
   Pan on bottom

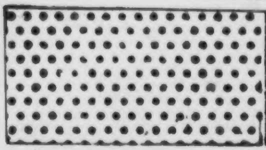
Soybean:
Set #17 grading sieves
Sieves H, I, & E -- for official grading
Sieves for a country station
   10/64 X 3/4 in. on top -- (determine splits)
   1/8 in. round hole
   Pan on bottom

Barley:
Set #19 grading sieves
Sieves B, L, or M, & E -- for official grading
Sieve for country station
   5½/64 X 3/4 in. slotted -- (determine thins)

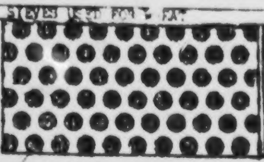
Oats:
Set #10 grading sieves
Sieves B, E, & F
Sieves for country station
   0.064 X 3/8 slotted -- for sizing
   5/64 in. triangle hole -- fine seeds in oats

SIEVES USED TO DETERMINE THE GRADE OF WHEAT,CORN,GRAIN SORGHUM & SOYBEANS

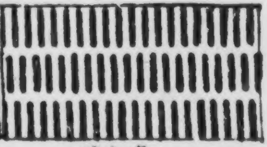
SIEVES USED FOR WHEAT



1/12 round hole
use for fine dockage

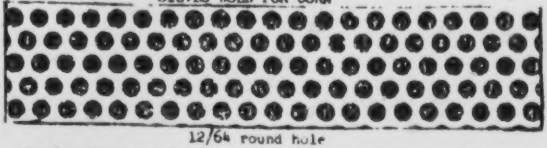


12/64 round hole
use for coarse dockage



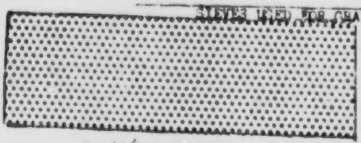
.064/x3/8 slotted
use for shrunken/broken

SIEVES USED FOR CORN

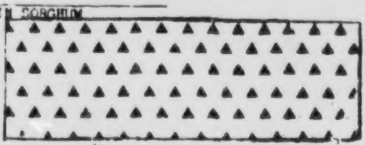


12/64 round hole
use for the removal of broken corn and foreign material

SIEVES USED FOR GRAIN SORGHUM

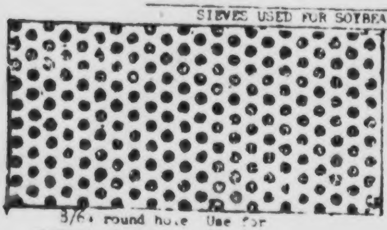


2 1/2/64 round hole
use for removal of dockage

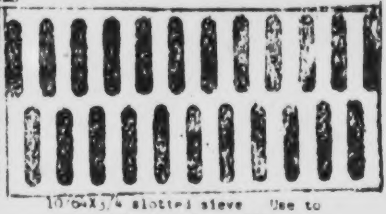


5/64 triangle hole
use for the removal
of broken kernels foreign material
and other grains

SIEVES USED FOR SOYBEANS



8/64 round hole Use for
removal of foreign material



10/64X3/4 slotted sieve Use to
assist in removing splits

GRAIN SORGHUM GRADING EXERCISE

#1 Grain Sorghums 93W and 7Y

Test weight ------58#
Moisture ---------12.5%
Sprouted Germ-----4.8%
Heat Damage --------------.3%
Broomcorn ----------------2.1%
Other foreign material ---1.6%

Complete grade and designation	Factor or factors

#2 Grain Sorghum 90Y and 10W

Test weight ------56#
Moisture ---------13.2%
Heat damage ------.3%
Wheat --------------------3%
Heat damaged wheat -------.3%

Complete grade and designation	Factor or factors

#3 Grain Sorghum 85W and 15Y

Test weight ------55#
Moisture ---------14%
Heat damage ------.3%
Sick Wheat ---------------2%
Foreign material ---------4.5%
distinctly discolored ---

Complete grade and designation	Factor or factors

#4 Grain Sorghum 99W 1%Y

Test weight ------57#
Moisture ---------13%
Foreign material ---------1%
Heat damage --------------.1%

Complete grade and designation	Factor or factors

#5 Grain Sorghum 92%W 8%Y

Test weight ----------56#
Moisture -------------14%
Heat damage - rye-----.4%
Heat damage - wheat --.3%

Heat damage G. S. ---------------.3%
Moldy Wheat ---------------------5%
Dockage ------------------------2.3%
250 smut masses in 500 grains

Complete grade and designation	Factor or factors

#6 Grain Sorghum 91%Y 9%

Test weight ----------52
Moisture -------------12.5%
Broken jewels --------2%
Flax -----------------1%

Heat damage --------------------.1%
3 live weevils ------------------
dockage .9%

Complete grade and designation	Factor or factors

#7 Grain Sorghum 82% 18% W

Test weight ----------55.5#
Moisture -------------14.3%
Heat damage broomcorn-.1%
Heat damage grain sorghum --------------.3%

Broken kernels ------------------3%
Dockage ------------------------2.4%
1 live weevil
15 smut masses in 50 grams

Complete grade and designation	Factor or factors

#8 Grain Sorghum 75W and 25Y

Test weight ----------54
Moisture -------------14.1%
Sprouted oats --------.3%
Other oats -----------6%

Rye ----------------------------2.2%
Discolored dockage -------------1.8%
3 dead weevils
15 smut masses in 100 grams

Complete grade and designation	Factor or factors

#9 Grain Sorghum 88W 12Y

Test weight ---------56#
Moisture ------------13.2%
Heat damaged corn ---.3%

Foreign material ------------4.0%
Heat damaged grain sorghum --.3
25 smut masses in 100 grams
Dockage 1.9%

Complete grade and designation	Factor or factors

#10 Grain Sorghum 91W 9Y

Test weight ---------55#
Moisture ------------14.0
Diseased barley -----4.0
Other barley --------7

Heat damage -----------------.3
Wheat ----------------------2.0
1 live weevil
Dockage ---------------------.9

Complete grade and designation	Factor or factors

#11 Grain Sorghum 90Y 10W

Test weight ---------56
Moisture ------------13.1
Heat Damage ---------.3
Broken Kernel -------4.2

Odor --------smutty
Distinctly discolored
2 live weevils
Dockage --------------------2.8

Complete grade and designation	Factor or factors

#12 Grain Sorghum 90W 10Y

Test weight ---------58
Moisture -----------11.

Heat damage -----------------.1
Other grains ----------------1.

Complete grade and designation	Factor or factors

PRECAUTIONS TO OBSERVE IN GRADING GRAIN

STATEMENT: Grain grading is a careful, exact and delicate procedure. It involves a designated sequence of steps, technical ability and knowledge, impartial judgment and a conscious effort to maintain a uniform, representative sample throughout the examination.

PROBLEM: What are the problem areas encountered in grain grading? How can you avoid incorrect and erroneous results? What steps must you take to insure accuracy?

QUESTIONS:

A. How do you obtain a representative grain sample?	1. Know the correct sampling techniques. 2. Use the proper equipment. 3. Make multiple probes into the load. Officially 5 is required. 4. Empty each probe on a canvas to check for inferior quality in the grain and its location. 5. Mix the probe samples together to get a uniform, representative sample for testing.
B. What precautions must you take for moisture?	1. Avoid open exposure to the air. 2. Place the sample into a moisture proof, air-tight container. 3. The moisture test is important in determining quality and grade of the grain. 4. Avoid handling the moisture test sample with your hands.
C. How should a sample be divided for grading?	1. Do not divide samples by pouring at random or scooping by hand. 2. To properly divide a sample, always use a Boerner divider. 3. A Boerner divider maintains the proper proportions of all material using a gravity flow system. 4. For smaller portions, continue to run one half of of the divided sample through the Boerner divider until the desired amount is obtained.
D. What problems can occur in grain storage even though a moisture test has been completed?	1. Moisture is important to grain trading because of weight, quality, conditioning and the storage life. 2. The temperature of the grain must be taken to determine a correction in the moisture value. 3. A reading by a moisture machine is only an average of the actual moisture content of the grain. It

	must be realized that both wet and dry kernels could make up a test sample. This would be true at the beginning of harvest. 4. "Hot spots" may develop from high moisture grain which gave a dry moisture reading on the machine This is a result of the averaging.
E. Why should you be cautious when running a weight per bushel test?	1. The weight per bushel test may determine the grade of the grain. 2. Weight per bushel is actually a quality test. 3. A filling hopper should always be used to determine the official test weight. 4. The filling hopper prevents the grain from packing and settling in the kettle. 5. Do not move the kettle until after the striking-off step. Move the filling hopper to one side, or remove it from the stand. Use care so as not to move the bench or kettle.
F. Why is it necessary to run a dockage test?	1. Dockage is the non-usable material found in grain. 2. Dockage may contain greater amounts of moisture than the grain itself. 3. Dockage always tends to bunch together when filling and emptying bins. As a result of bunching, air flow and moisture migration is inhibited. 4. Flour mills and processors do not want to buy waste material that they cannot use. Therefore dockage is used as a buying tool.
G. Is it necessary to hand pick a sample of grain for foreign material?	1. The sample may contain seeds of the same size as the grain. ie. oats may contain wild oats, wheat may contain buckwheat. 2. Gravel or stones the same size as the grain may be present in the sample. These are known as inseparable stones and must be hand picked to remove them. 3. Stalks, stems and seeds that were not removed during the dockage test must be removed by hand picking the sample. 4. There may be sufficient foreign material in a sample to lower the official grade. Therefore, the quality of the grain is lower.
H. Why is grain grading important?	1. It is the process of establishing a uniform standardized measurement of grain quality.

2. It is used to determine standard grades for buying and selling grain.
3. It is done by impartial persons licensed by the state or federal government.

I. Conclusion

1. Grain grading is important. It allows people to understand each other in common terms in a grain trading language.
2. Measurements in offically grading grain are critical. They determine the market value of that grain.
3. Great care must be used to avoid erroneous results, which might cause mistakes in conditioning and storage.
4. Grading cannot be effective unless official equipment is used and used accurately.
5. Grading is done by people, so, mistakes are possible. However, a conscious person will keep these to a very minimum.
6. A protest can always be placed and a re-check made of the grain when graded by the state grains lab, if you are not satisfied with the grade.

GRAIN GRADING AT THE LOCAL ELEVATOR

PROBLEM: What sequence of steps and measurements should be taken at a local elevator to arrive at a fair market value for a load of grain?

STATEMENT: Many factors are involved in receiving and grading grain at a local elevator. Marketing grain and recovering the elevators expenses depend upon how effective you are in weighing and grading of this grain. Board and management policies are to be followed in accepting grain across the scales, however, accuracy, common sense and courtesy will determine your ability to effectively grade grain.

There are three things in addition to standard operating procedures that will determine the sequence of steps you will use for grain grading. These are, the crop season, the stage of harvest and the time of year. Any one of these will directly affect the grading steps and procedures followed. ALWAYS, if a test or grading procedure is undertaken, do it correctly, accurately and with a professional attitude.

STEPS EXPLANATION OF PROCEDURE

Step 1 Observe the load of grain to identify the commodity.

Step 2 Weigh the load of grain.
A. Use correct ticket. ie. inbound, outbound or courtesy weigh.
B. Visually read the scales as the truck drives onto the platform.
C. Make ticket position adjustment for Gross or Tare weight
D. Weigh the load with the driver in the truck.
  1. Co-op policy will determine if all drivers are to stay on or off.
  2. Observe if there is more than one person in the truck weighed with the driver.
  3. Be sure the scale indicator has stopped moving before weighing the truck.

Step 3 Uniformly sample and probe the grain.
A. Use an approved procedure to probe the grain.
  1. Follow good techniques, do not use a coffee can or your hands.
  2. Depending on time and the season, probe more than once into a load.
  3. Do not probe in the same location each time.

B. Obtain a sufficient quantity to--
   1. Be representative of the load.
   2. Be complete and accurate on all tests.

C. Observe the total load when probing.
   1. Look for good color in the grain.
   2. Look at the shape of the load to indicate the moisture content
   3. Watch for large stones, broken glass, trash and any foreign material.
   4. Note the general condition of the grain.

Step 4 Smell the grain sample.

A. Grain should smell clean, fresh and free of objectional odors. A "nutty" smell.

B. If an odor is detected, four things should be done.
   1. Immediately re-sample the load.
   2. Have the patron or driver smell the sample.
   3. Note the odor on the scale ticket.
   4. Instruct the elevator crew for dumping.

Step 5 Make visual checks during the remainder of the grading test.

A. Watch for stones or glass in the sample.

B. Look for rodent pellets or bird excreta.

C. Observe any "Pink" kernels.

D. Note any other grain in the sample, that is of significant quantity.

Step 6 Determine weight per bushel.

A. Use the proper equipment for test weight.

B. Strike off the kettle once, using 3 zig zag motions.

C. Determine the correct test weight.

D. Record the results on the scale ticket.

Step 7 Determine the moisture content of the grain.

A. Weigh out appropriate grams from the test weight kettle. Use care to weigh the amount exactly. (Most testers will require 250 gms.)

B. Carefully balance the moisture tester. Make sure the tester has had sufficient time to warm up.

C. Place the weighed sample into the temperature chamber.
   1. If a temperature chamber is not part of the machine, use a thermometer.
   2. Use care in placing the sample into the temperature chamber, DO NOT SPILL ANY. Spilling can cause an erroneous reading.
   3. Wait 2 minutes before reading the temperature.

D. Check the moisture chamber to be sure the previous sample was removed.
E. Drop the sample into the testing chamber and read the moisture level on the dial.
   1. Jot down the moisture reading.
   2. Jot down the temperature correction obtained from the appropriate grain chart.
   3. Compute the corrected moisture value.
F. Record moisture content of the grain on the scale ticket.

Step 8 Dockage test for wheat or broken kernels, foreign materials for corn.

A. Experience, crop season, policy and obvious amounts of dockage or cracked and broken kernels will determine when to run this test.
B. See attached list.
C. Weigh out 250 or 500 grams of grain. If Boerner divider is available use it to divide a sample to the exact predetermined weight.
D. Place the total sample on the top sieve and shake horizontally - 30 round trips.
E. Weigh the coarse and fine dockage together for wheat, or the broken kernels and foreign material for corn. Record this weight.
F. Compute the results as a percentage of the original weight.
G. Record dockage on the scale ticket of 0.5% or more for wheat and 2.0% or more of broken kernels and foreign material for corn.

Step 9 Check for damaged kernels.

A. Use a small weighed portion (60 gm.) of the sieved grain to determine the damage.
B. Damaged kernels may be:
   1. Wheat - Sick wheat, heat damaged, scab, weevil cut, sprouted, frosted, fungus and green immature kernels.
   2. Corn - Dryer damage, heat damage, mold sprouted, weevil cut and cob rot.
C. Use tweezers and a sharp blade to determine germ and kernel damage.
   1. Scrape the germ to make it visible.
   2. A color of milk white indicates a good sound germ.
   3. Cut a kernel in half to observe color of the starch.
   4. Other damage can be seen in exterior color change, seed coat change or weevil cut kernels.
D. Weigh the damaged kernels removed from the sample and compute a percent.
E. Record on the scale ticket, the kind of damage and the percentage of total damage.
   1. Wheat - in addition to damaged kernels you will need to look for shrunken and broken kernels.

2. Corn - if heat damage is present, a second percentage is counted in addition to the total damage.

Step 10 Complete the scale ticket

A. Make sure you have entered the correct value or number in each of the following:
    1. Commodity
    2. Gross weight
    3. Moisture
    4. Test weight
    5. Dockage or broken kernels
    6. Special grade, ie. weevily.

B. Make sure you sign or initial the scale ticket to show who officially weighed and graded the grain.

C. As previously mentioned, double check to make sure the patrons name is correct and elgible.

Step 11 If the grain is substandard, shows a low quality factor, or has an abnormality, be sure to discuss and confer with the patron. This allows him to know what the problem is, why a notation must be made, and wheat he can possibly do to correct it.

Step 12 Inform the elevator crew of the proper binning instructions.

IDENTIFICATION OF FARM GRAIN STORAGE DAMAGES

1. CORN

Classes:
1. Yellow - no more than 5%
2. White - no more than 2%
3. Mixed - does not meet Yellow or White

Broken corn and foreign matter - use a 12/64 seive - also any matter other than corn that stays on top of seives

Principle Corn Kernel Damages:
1. Cob rot - corn harvested on cob and stored on the cob, can occur in field
2. Blue-eye rot - germ of seed is affected with blue-eye mold, any spot on germ
3. Black germ damage - dark color due to black mold on germ; must cover all of germ and must remove germ cover to see it
4. Heat damaged - caused by heat; must be black or mahognany color all around kernel
5. Insect damage - holes in grain
6. Sprout damage - germ broken open from germination
7. Germ damage - caused by dryer, only the germ is damaged

2. SORGHUM

Classes:
1. Yellow
2. Brown
3. White - may not contain over 2% sorghum of other color
4. Mixed

a. Distinctly discolored - not above Grade 3
b. Badly weather damaged - Sample Grade

Damages in Sorghum:
1. Heat - Dark discolored kernels
2. Black germ - caused by heat, unable to detect just by looking at it. Mix 15 gm of grain with 70 mililiters of bleach and potassium hydroxide, mix for seven minutes, seed coat will be removed and black germ damage can be observed

3. Sprout - embryo protruding above germ coat
4. Weevil - holes cut into grain
5. Mold - gray moldy appearance of seed coat and musty smelling
6. Badly weathered and ground damage - dull appearing grain, caused by being left in field too long, heads may have been on the ground on field under water

Sample Grade Factors:
1. Weevily - 2 live weevils
2. Smutty balls or spores

3. WHEAT

No subclasses any more D.H.V.
Dockage - remove mechanically from wheat
Shrunk and broke - U.S. 64/100 X 3/8 sieve
Wt./bu.
Heavy - 62# + (no more)
F. M. - not removed as dockage
When sieving - run the cracks parallel to the motion

Red Durum - no longer grown commercially, put in unclassed wheat

IMPORTANCE OF PROPER SAMPLING

If question of bugs in grain - stick arm in it and bugs will stick to hair on arm.

Soft Red Winter - larger broad germ and lay back seed coat, back has a textured appearance, cheeks are open; this type is moving into this area

Hard Red Winter - germ smaller, seedcoat is smoother, sharper cheeks, crease will be tighter, distinct line down the back of kernel

DAMAGES

Field Damages:
1. Blacktip fungus - also storage - on tip and over germ around shoulders and into the crease, moisture standing in head of wheat, black in crease can't be removed by miller
2. Green immature kernels - different varieties mixed in the field, early and late maturing
3. Frost damage - blistering, darkening of seed, wrinkled seedcoat, happens with a late frost and wheat is in milk stage, does not mill properly, will gum up rollers
4. Lite test weight - hot weather during dough stage, shortage of moisture, Mosaic, Hessian fly

Diseases in a Field:

1. Scab damage Gibrillan molds Tombstone - dead, lifeless wheat, caused by blighted plants
2. Sprout damage - wet conditions and stand sprouting in head, internal chemical composition is changed
3. Ergoty - a growth in wheat, grows in head of wheat; at one time was wheat; is harmful to animals causing them to abort young; caused black death in some people who consumed in many years ago; "lysurgic acid" - found in ergot and LSD, has halluciogenic properties

Storage Damages of Wheat:

1. Black germ damage - oil in germ has turned dark and rancid, remove seedcoat over germ, stored with too much moisture; also called "Sick Wheat"
2. Heat damage - functions by itself first and then goes with total damage, starch is dark all the way through
3. Insect damage - will take on a distinct sour, urine odor, if kernel is eaten on it is not a damaged kernel, but if the inside is eaten out or holes are bored into it, it is a damaged kernel
4. Blacktip fungus - continues to develop in storage

SAMPLE GRADE FACTORS

fertilizer, hides, oils (out of coal oil or diesel gas)
skunk, decayed animal and veg. matter

1. C.O.F.O. - Commercial Objectionable Foreign Odors
2. D.L.Q. - Distinctly Low Quality

1. Crotalaria - heart shaped waxy-yellow to black; resembles velvet leaf except is rough textured
2. Stones - not more than 7 in 1,000 grams
3. Treated wht.
4. Rodent excreta - not more than 2/1,000 grams

SPECIAL GRADES - does not affect numerical grade

1. Smutty - spores over winter in ground; light smutty odor, brush and will hold the smutt odor, odor is pungent
2. Garlicky
    a. Light - 2-6/1,000 grams
    b. Garlicky - 6 or more/1,000 grams
3. Weevily - live insects
4. Treated
5. Tough - no more actually list moisture content on certificate

Insect eggs in wheat are not killed during milling of wheat; so after the housewife buys flour and it sets in a warm moist room for a while, (28 day life cycle), then she opens bag and finds bugs.

Dockage vs. Foreign Material (F.M.)

1. Dockage - USDA Definition (Key words appropriate sieving & screening devices)
2. F. M. - Same size, density and shape
   must be hand picked
   Examples:
   a. In wheat - milo, rye, cheat, joint grass
   b. Corn - soybeans (& vise versa)
   c. Milo - wheat
   d. Barley - oats, rye

PROCEDURES FOR SIEVING GRAINS TO DETERMINE QUALITY AND GRADE

Reference: Procedures for Hand Sieving Wheat, Corn, Sorghum and Soybeans to Determine Quality Grade, Kansas State University, No MF - 436.

Wheat

I. Representative Sample - Wheat

II. Odor

III. Visual Check

D.L.Q., Weevily, Garlicky

IV. Visual Check for Mixed Grain

V. Moisture Content

250 gm. and temp.

VI. Dockage Test - 500 gm.

Dockage Kicker - Top Sieve - coarse - round 12/64
Middle - fine - round 1/2
Bottom - pan -

Determine % and Record

VII. Wt./Bu. with Dockage Free Sample

VIII. Boerner Divider

A. 250 gm - shrunken and broken, oblong .064 x 3/8 pans

B. 60 gm - foreign material - hand pick, anything other than wheat

C. 15 gm damaged kernels

Corn

I. Odor

II. Visual Check

Live insects, type of kernels, stones, mixed grain

III. Moisture

250 gm. and temp.

IV. Weight Per Bushel - Complete Sample

V. Cracked Kernels and Foreign Material

500 gm. sample - 12/64" #12 sieve

VI. Damaged Kernels

250 gm. hand pick- any type of damage

Soybeans

500 gm - Foreign Material - anything including S.B. that passes thru an 8/64" sieve and then hand pick anything other than S.B. that stayed in the original sample

30 gm - Splits, Hand Pick

15 gm - Determine total damage and heat damage of Only S.B. - Hand Pick

15 gm - Determine brown, black or bicolored S.B. Only - Hand Pick

Sorghum Grading

500 gm - Dockage 2½ x 64 Round Hold Sieve

250 gm - Broken kernels, F.M. and other grains will pass through 5/64 triangular seive, and other material which remains on top sieve.

15 gm - Determine damage dkernels of any grain and heat damaged kernels of any grain - Hand Pick

Sample Name & Number	Odor	Moisture %	Dockage %	Test Weight	Shrunken & Broken Kernels	Foreign Material	Total Damaged Kernels	Total Defects	Dark Hard Vitreous	Heat Damaged	Color	Other Factors	Grade and Determining Factors

CHAPTER IV

MOISTURE CONTROL

CHAPTER OBJECTIVE

After completion of this chapter the student will be able to distinguish between various kinds of grain drying equipment, identify drying and aeration equipment, explain various types of systems listing the advantages and disadvantages of each.

TEACHING AIDS AND STUDENT ACTIVITIES

1. Dryer Brands Mailing Address - Write for company literature.
2. Visit farm dryer installation and commercial dryer installation.
3. Company representatives speak to class about dryers.
4. Have students test grain for moisture and test weight before and after drying.
5. Burdick Aeration Booklet, Decatur, Illinois 62525
6. Research Papers by:
    a) Dr. T. L. Thompson, Asst. Prof. Ag Engineer, University of Nebraska.
    b) Dr. Harry Converse, Agriculture Research Service, USDA, Manhattan, Kansas

SUPPLEMENTAL REFERENCES

1. Drying - Aeration - Fumigation Manual, Farmland Industries, Kansas City, Mo.
2. A Guide to On-the-Farm Grain Drying and Aeration by Ronald G. Surma, Combustion Equipment Company.
3. Aeration of Farm Storage Grains, Kansas State University, Extension Publication, E-26.
4. Testing Grain Moisture on the Farm, Kansas State University, Extension Publication, E-33.
5. On-Farm Grain Drying, Kansas State University Extension Publication, E-12.

6. Low Temperature Grain Drying, Kansas State University Extension Publication, E-32.
7. Drying Cereal Grains by Brooker, Bakker-Arkema and Hall.
8. Grain Storage, the Role of Fungi in Quality Loss by Clyde M. Christensen, Henry H. Kaufmann.

STUDENT STUDY GUIDE

The following terms and questions should be answered from the Technical and Instructional Material or Supplemental References.

Dry Matter -

Shrink -

Relative Humidity -

Dew Point -

Aeration -

Cubic Feet Per Minute -

Static Pressure -

Down Draft -

Up Draft -

Push-Pull -

Axial Fan -

Centrifugal Fan -

STUDY QUESTIONS

1. What do the letters CFM stand for?

2. Explain the difference in Crossflow and Counterflow?

3. List the advantages of a batch dryer.

4. List the advantages of a continuous flow dryer.

5. What does a dryer rating of 5 points per hour mean?

6. Give the 10 most critical questions that should be answered before a dryer is purchased.

7. What would be the per cent loss from original weight of grain if the original moisture was 22% and final moisture was 15.5%?

8. Approximately how many BTU's are required to remove one pound of water from a bushel of grain?

9. Which fuel source of Natural Gas, Propane, or #2 fuel oil provides the most BTU's?

10. List 10 benefits to using aeration?

11. Explain the difference between updraft and downdraft aeration?

12. Which aeration system offers the most advantages for conditioning and storing corn?

13. How many minutes does it take for air at 1/10, 1/20 & 1/30 aeration to pass completely through the bin?

14. Explain and compare crossflow, concurrent flow and counterflow dryers.

15. In commercial grain handling what is the amount of shrink an elevator would generally have for each 1% moisture shrink? __________

16. What would be the per cent weight loss when drying grain if the original moisture content of corn was 28% and it was dried to 15.5% moisture. (Use Figure II) __________

17. In reference to Figure III how many pounds of moisture are removed from each bushel of corn, milo, oats, wheat and soybeans if the original moisture for each is 22% and they are dried to 12%.

soybeans __________ oats __________ corn __________

milo __________ wheat __________

18. Give the advantages and disadvantages of:

Updraft Aeration

advantages -

disadvantages -

Downdraft aeration

advantages -

disadvantages -

19. The volume of air required is determined by multiplying _____ by the number of bushels in the bin.

20. Which type of duct pattern or design provides the best air distribution in a bin? _____________ Why?

21. List the advantages of using Axial fans for aeration?

22. Give the advantages of using centrifugal fans for an aeration system?

23. Using the static pressure charts find the static pressure for each set of given conditions.

	depth	cfm	static pressur
Corn	100	1/5	
Wheat	50	1/30	
Soybeans	40	1/2	
Milo	70	1/7	

24. List advantages and disadvantages of using acid preservative treatment on high moisture corn.

    advantages -

    disadvantages -

25. Explain how long aeration fans should run when the moisture on a bin of corn is 18.5% and it is raining?

26. Should wheat stored at 13% moisture have aeration fans turned on? Why?

27. To double the airflow rate in a grain bin will require how much more horsepower, and air volume?

BRANDS OF DRYER'S

Name	Mailing Address	Telephone
American	American Farm Equipment Co. 340 E. Main Street Lake Zurich, Illinois 60047	1-312-438-2151
Superb Super "B"	Beard Industries Highway 28 West Frankfort, Indiana 46041	1-317-654-8517
Berico	Berico Industries Box 8417 Shawnee Mission, Kansas 66208	1-913-262-6377
HC Dryers (Old Model Shanzers)	Carter-Day 502 73rd Ave. N.E. Minneapolis, Minn. 55432	1-612-571-1000
Chicago	Chicago Grain Systems 200 N. Prospect Street Marengo, Illinois 60152	1-815-568-7264
Delux	Delux Manufacturing Co. Box Q Kearney, Nebraska 68847	1-308-237-2275
Driall	Driall, Incorporated Box 309 Attica, Indiana 47918	1-317-295-2255
Clipper & Town & Country	Ferrell-Ross 1621 Wheeler Street Saginaw, Michigan 48602	1-517-792-8723 Telex 227-464
M & W	M & W Grain Dryers Route 47 South Gibson City, Illinois 60936	1-217-784-4261
Meyer	Meyer Morton Co. Morton, Illinois 61550	1-309-267-7159
Redex	Redex Industries, Inc. P.O. Box 349 Elm Creek, Nebraska 68836	1-308-856-4636
Shanzer (new)	Shanzer Grain Dryer Box 834 Sioux Falls, South Dakota 57101	1-605-336-0439
Zimmerman	Zimmerman Equipment Co. Litchfield, Illinois 62056	1-217-324-3987

TECHNICAL AND INSTRUCTIONAL MATERIAL

Introduction

Between 1950 and 1975 the harvesting, handling and conditioning of grain has taken on a totally new concept. The movement to put electricity on every American farm had reached its peak by 1950. Probably no other development so single handedly launched agriculture into the intensive farming practices now observed by producers.

However, three significant developments following 1950 have pushed American Agriculture to its new technological high. Producers adopted the practices of using Hybrid seed, fertilizers and chemicals, and mechanized hydraulics. These advancements have enabled the producer to increase his production 5 fold.

During the 1960's research told the producer he could reduce his field losses by harvesting some grains at higher moisture contents. Corn at 26-28%, milo at 20-22% and wheat at 14-15% moisture. Machinery companies responded to the farmers need for larger more powerful equipment. The new pickers, shellers and threshing machines could harvest between 50 and 100 acres per day. Couple these developments with the intense desire of the producer to begin and finish his harvest at the earliest possible dates and we have created a new problem. What to do with the large volumes of wet grain being harvested during the first days of harvest? New techniques and methods had to be developed for handling grain - particularly corn.

Corn at one time had been left on the stalk to mature and dry. Later the practice of picking the ears and storing them in a crib became the harvesting method. Corn left on the ear would dry down naturally by transferring moisture from the kernel to the cob. The practice of "picking" has given way to the modern technique of shelling high moisture corn at the time it is harvested. To reduce the moisture content, producers and grain elevators artificial dry corn and other grains with heated air.

Artificial Drying

There are principally two techniques used to dry most of todays grain. The technique of drying with commercial dryers and the technique of drying with aeration. Two other drying methods are under research and will require extensive and continuous testing before they become economically feasible. They are the process of drying with solar energy and electric microwave drying.

Todays energy concerns dictate a need to look at some of our current grain conditioning techniques. There is more energy required to dry and condition most crops than is required to till, plant and harvest. One certain alternative is to leave the crops in the field until they mature and dry down naturally. However, natural disasters of wind, rain, hail, snow, and flood cause a high per cent field loss and seem to make that alternative impractical. This leaves the alternative of artificially drying grain with heated air.

There are numerous combinations of drying and aeration equipment used to reduce the moisture content of stored grain. Varying only in the size of the equipment most systems are similar whether they are on the farm or at commercial elevators.

The most popular and frequently used type of drying system employs a grain dryer. The dryers are identified and referred to by the movement of grain through the dryer itself. The two types of dryers are continuous flow and batch. In a continuous flow the grain is elevated to the top of the dryer and allowed to move down through the dryer in a uniform column. The speed at which the grain moves through is controlled by feed augers at the bottom of the dryer. The faster the augers turn the faster grain moves through the dryer. The slower they turn the slower the grain moves. Large continuous flow grain dryers are very sophisticated and can run on a series of automatic controls.

Batch dryers are generally found on the farm. They handle smaller volumes of grain and are less expensive to buy. A batch dryer must be operated in steps. It has to be loaded with grain, turn on burners to dry the grain, turn off the burners and cool the grain followed by unloading. Generally speaking, they are more cumbersome and require very close supervision and monitoring of the grain and the dryer. A few batch dryers have had automatic controls added to eliminate some of the demanding attention. However, the problem of small batches and low capacity still exists. The time spent loading, unloading and cooling the grain could be time and energy spent drying additional bushels.

Because corn is the most frequently dried grain and is a widely grown crop, dryers are rated on a corn basis. The rating will state how many bushels can be dried per hour removing a specific number of moisture percentage points. For example, a dryer may be rated at 750 bushels per hour removing 5 points of moisture from 20% down to 15% moisture. A larger dryer may be rated at 4000 bushels per hour (bph) removing 5 points from 22% moisture down to 17% moisture. Each company conducts field tests on their dryers and can provide various drying rates. As you increase bushels per hour you reduce the amount of moisture removed.

There are several factors you need to understand when comparing grain dryers. Two dryers with exactly the same rating published in their literature will dry at different capacities when setting side by side on the job. The ten questions listed below are questions that should be ask of a dryer salesman and his company.

1. What was the airflow rate used during the drying test?

2. What was the inlet temperature and outlet temperature of the grain?

3. What was the intake air temperature and humidity opposed to the exhaust air temperature and humidity?

4. How clean was the grain going into the dryer?

5. How long was the test conducted, where was it conducted and have the results been repeated?

6. How many BTU's was required to dry each bushel?

7. What was the corn quality and breakage at the discharge after drying?

All of these questions should be answered and compared. Particularly questions 6 and 7. They directly contribute to out of pocket expenses that must be controlled. The last three questions deal with thermodyamics and psychometrics. Never the less, they are important questions to help in a decision making process.

8. Service. Who is the local representative and can they take care of your needs?

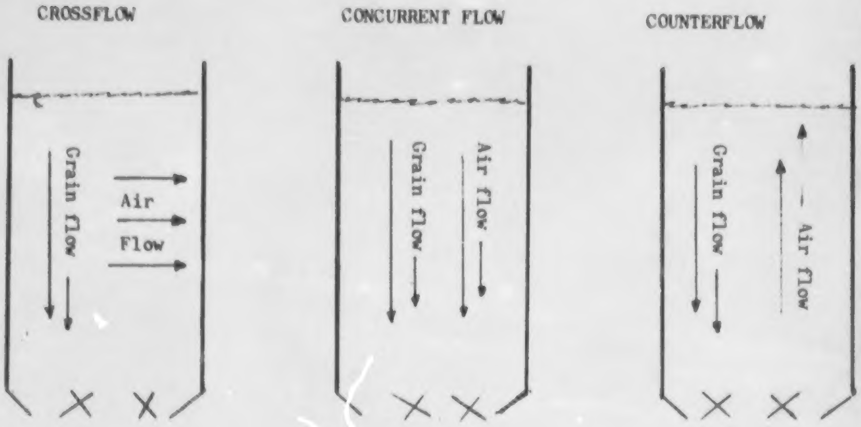
9. Space requirements vs. design. Where will the dryer be located and how will it fit in the flow of grain?

10. Price vs. personal preferance. How does the final price compare with your choice or your past experience?

Generally all other questions will be answered through company literature or by a salesman. These 10 questions are the ten most critical questions you should ask when selecting the drying most suited to your needs.

Grain dryers are designed to move heated air around, over and through wet grain. In order to accomplish this they design the dryers so grain flows between two perforated metal screens that are a fixed distance apart. Dryer companies will use 9 inch columns, 10 inch columns and some 12 inch columns of grain. Depending upon the direction of air flow through the grain columns, grain dryers will have one of three classifications. Figure I shows the relationship of air movements to grain movement. Crossflow is the most common and most popular design.

Modifications of various bin drying systems are used on the farm and have had some success but require intensive management and additional expense for the equipment. The various systems used are low temperature drying, batch-in-bin drying and stirred batch-in-bin drying. In all cases, the grain dries quicker and maintains higher quality if grain depth is kept between 4 and 8 feet. With stirring devices greater depths can be achieved. However for low temperature and in-bin-drying 4-6 feet is optimum.



Direction of grain and airflow in three basic types of grain dryers.

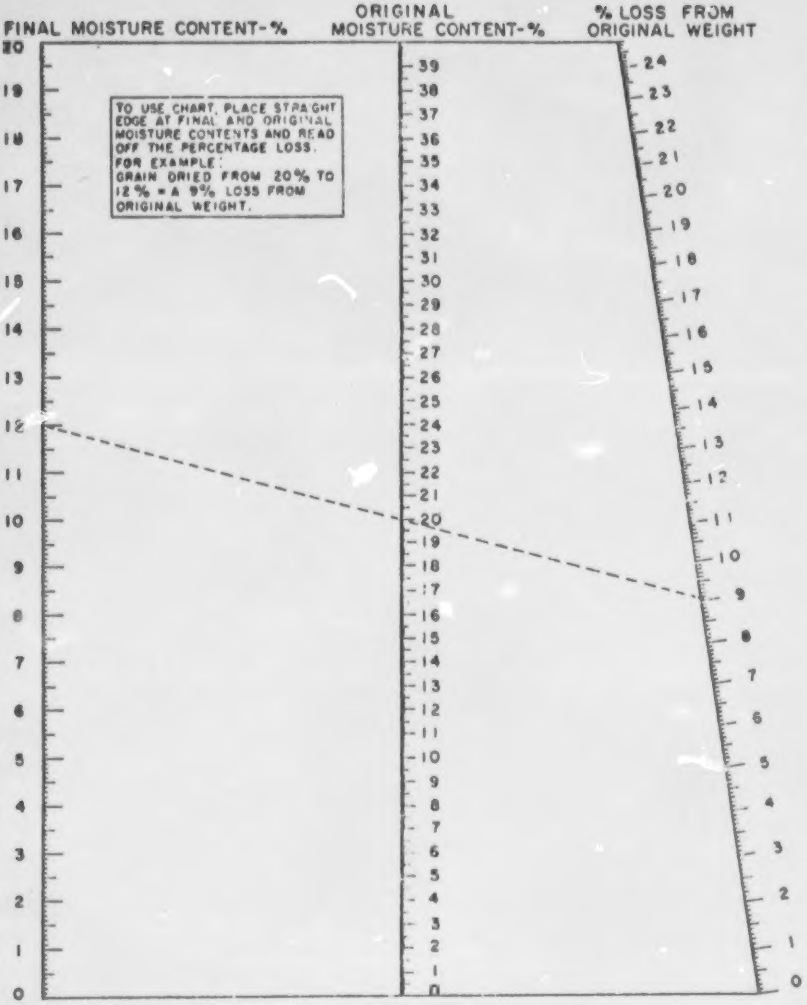
FIGURE I

Another modification is dryeration. Dryeration uses drying and aeration at timed intervals to dry corn. Grain is dryed down to approximately 18% moisture but not cooled. It is moved to a holding bin or tank and allowed to heat or steep for 8-10 hours. The grain is again moved and cooled very quickly with high volume aeration. The steeping process followed by rapid cooling will remove and additional 2½ to 3 percentage points of moisture. The grain is again moved into a final storage position, with aeration available. The disadvantage of dryeration is intensive management and the tie-up of a lot of bin space. However, the reduction of stress cracks and higher quality corn are distinct advantages.

Drying and Moisture Shrink

Whenever grain goes from a growing plant to a maturing seed it loses moisture. Storage of grain at safe moisture levels for more than 8 months requires the moisture to be below 14 percent. If corn will be used for livestock feed or moved into market channels before that time period it can be held at higher moisture levels.

Grain dried down to safe storage levels causes a shrink to take place. This shrink is of paramount importance to a grain merchant and should be of interest to the grain producer. Depending upon the variety of the corn, the original moisture content and the temperatures used to dry the grain, the shrink factor will be greater than 1% for each one percent moisture removed. The cart shown in figure II will help you determine what the percentage loss from the original weight would be. Note the example indicated by the dotted line. The small box inset.



TO USE CHART, PLACE STRAIGHT EDGE AT FINAL AND ORIGINAL MOISTURE CONTENTS AND READ OFF THE PERCENTAGE LOSS.
FOR EXAMPLE:
GRAIN DRIED FROM 20% TO 12% = A 9% LOSS FROM ORIGINAL WEIGHT.

CHART FOR ESTIMATING WEIGHT LOSS WHEN DRYING GRAIN OR SEED.

FIGURE II

POUNDS OF MOISTURE PER BUSHEL OF GRAIN

MOISTURE, PERCENT	GRAIN SORGHUM *	SHELLED CORN +	WHEAT AND SOYBEANS ‡	OATS ‡
30 -------------	20.6	20.2	22.1	11.7
28 -------------	18.7	18.4	20.1	10.6
26 -------------	16.9	16.6	18.2	9.6
25 -------------	15.7	15.7	17.2	9.1
24 -------------	15.2	14.9	16.4	8.6
22 -------------	13.6	13.3	14.5	7.7
20 -------------	12.0	11.8	12.9	6.8
18 -------------	10.6	10.4	11.4	6.0
16 -------------	9.2	9.0	9.8	5.2
14 -------------	7.8	7.7	8.4	4.4
12 -------------	6.6	6.5	7.0	3.7

* FIGURED AT 56 LBS. PER BUSHEL AT 14%.

+ FIGURED AT 56 LBS. PER BUSHEL AT 15.5%

‡ FIGURED AT 60 LBS. PER BUSHEL AT 14%.

‡ A BUSHEL OF OATS IS DEFINED AS 32 LBS. OF OATS AT 14 ½% MOISTURE; DRY MATTER PER BUSHEL IS 27.4 LB.

NOTE: CALCULATED SHRINK FACTOR OF APPROXIMATELY 1.165% PER POINT OF MOISTURE OVER THE STANDARD ALLOWABLE MOISTURE.

Figure III

Every bushel of grain contains some moisture. It can be said that grain is made up of dry matter and moisture. Together, these two items make up the test weight for a bushel of grain. The drier grain has less pounds of water making up part of the test weight. For example, corn has a test weight of 56 pounds per bushel. However at 30% moisture there is 20.2 pounds of water making up part of the 56 pounds. At 16% moisture there is only 9.0 pounds of water that make up part of the 56 pounds. (See Figure III.) The point is that dry matter makes up the true value of a bushel of grain and there is more dry matter in 16% moisture grain than there is in 30% moisture.

Because part of the dry matter is driven off with the moisture there is a greater shrink that occurs. Laboratory research shows the shrink to be about 1.2% for each 1% moisture. In actual practice of day to day grain operations shrink is 1.5% for each 1% moisture removed. (See Chapter 6 for additional explanation.)

Energy Consumption

As a grain dryer removes moisture it consumes energy. As a rule of thumb dryers will use approximately 2000 BTU's to remove one pound of water. Many new dryers manufactured today are more effecient than the "rule of thumb" and can in fact remove a pound of water using 1500-1600 BTU's. The pounds of water per bushel of grain chart (See Figure III) can be a quick reference to determine the number of pounds of water removed from each bushel. Simply find the difference in pounds of moisture between original and final moisture content and multiply by 2000 BTU to determine the energy requirements per bushel.

As an example, find by subtraction how many pounds of water are removed from each bushel when corn is dried from 24% down to 14%? A tremendous amount of energy is consumed unnecessarily if the producer harvests the grain too wet or the dryer dries the grain too dry.

Different fuels provide different amounts of energy. Selecting a fuel or determining which fuel should be your cheapest back-up source requires some comparison. The only complete and fair comparison is to measure the fuels in terms of BTU's or British Thermal Units. Figure IV provides several fuel sources with their common measurement in BTU's and a comparitive measurement of BTU's per pound.

APPROXIMATE HEATING VALUES

Fuel Source	BTU	Weights in Pounds of Fuel	BTU/lbs.
Natural Gas	1,021/ft.^{3}	0.046/ft.^{3}	22,190
Propane* (vapor)	2,519/ft.^{3}	0.117/ft.^{3}	21,590
Propane* (liquid)	91,690/gal.	4.247/gal.	21,590
No. 2 Fuel Oil	138,500/gal.	7.11/gal.	19,480
Kerosene	127,300/gal.	6.82/gal.	18,660
Bituminous Coal			13,500
Wood			7,100
Electricity	3,413/KWH		

*Conversion from liquid to vapor is 36.39 ft^3/gallon.

EXERCISE I

To effectively compare least cost fuels you need a price delivered or piped to your dryer. Obtain those prices for your immediate location and write them into the proper spaces. Determine which fuel is the most expensive and the least expensive.

UNIT PRICE FOR FUEL

Natural Gas (ft.^{3}) ____________________

Propane (gallon) ____________________

No. 2 Fuel Oil (gallon) ____________________

Kerosene (gallon) ____________________

Electricity KWH ____________________

Other ______________ ____________________
Source

Aeration

Aeration has become an adopted practice among paroducers in the last 15 years and used by commercial grain storage companies for the last 30 years. The science of aeration is still being developed. Most of the engineering is complete, but the art of operating and managing aeration equipment is still being learned.

Aeration is for the express purpose of moving natural air - outside air - through grain to prevent deterioration. New ideas and innovative thinking has offered aeration several advantages in recent years. Some of those advantages and benefits are listed below.

1. Minimize or prevent mold growth
2. Reduce and eliminate insect activity
3. Equalize grain temperatures
4. Prevent moisture migration within the bin
5. Remove odors from the grain

6. Eliminate frequent turning of grain to maintain condition
7. Reduce moisture content
8. Hold high moisture grain until drying can be done
9. Aid in the process of dryeration
10. Be used to apply grain fumigants

Aeration Systems

A great number of questions have been raised by various individuals about the best type of an aeration system to have. Part of the difficulty arises from the fact that few people understand the limitations of their system and know what they were designed for. The other problem is understanding the principles of aeration involving static pressure and air flow rates.

First, lets discuss the different types of systems and how they function. Then we will discuss the advantages and disadvantages of each.

Downdraft Aeration - is where all of the air movement is down through the grain from top to bottom. The aeration fans are found mounted at the bottom of the bins or silos and pull the air down.

Updraft Aeration - is where all of the air movement is up through the grain. Fans maybe mounted either at the bottom or on top of the bins or silos. If a fan is mounted at the bottom it must be pushing air up through the grain. If a fan is located at the top of the bin it will be pulling air up through the grain.

Crossflow Aeration - is where the air movement is across the grain bin from one side to the other or from the center toward the outside.

Push-Pull Aeration - is a combination of two or more fans working together to move the air in the same direction. One fan will be mounted on top and one fan will be mounted on the bottom. The direction of air flow may be up or down but in the majority of systems the air will move upward.

Advantages for Updraft (pushing)

1. Natural cooling can occur more rapidly as the warmest areas lie near the surface.
2. If warm grain is loaded on top of grain that has already been cooled the warm air is driven from the bin upward and is not drawn down thru the already cooled grain.

3. Slight heating of the air by 1-2 degrees (sometimes achieved by fan heat) due to the compression of the air, can reduce the relative humidity of the air and aid in drying or reducing the chance of moisture increases in the grain.

4. Temperature measurement in the grain is easier when air is blown upward. The warmest areas are near the surface and can be probed.

Disadvantages of Updraft (pushing)

1. A greater possibility that warm air from aerated grain may cause condensation under the roof - particularly if the grain is warm or has been allowed to heat up and the ambient temperature is cold. The greater the air space above the grain the smaller the chance for condensation to occur.

2. It is possible for the grain to absorb moisture around the duct.

3. If fans are operated around dusty or dirty areas it is possible for the ducts to become blocked.

4. Aeration cannot be effective unless the ducts are completely covered.

5. May be necessary to protect the fans from outside moisture being forced into the ducts.

Advantages of Downdraft (pulling)

1. There is usually no condensation of moisture provided the exhaust air is vented outside of the bin or building.

2. Any moisture increase from high relative humidity of ambient air will be spread out over the entire surface of the grain as opposed to the concentration around the duct.

3. Aeration ducts are not likely to be blocked with dust during operatio but collected in the grain mass instead.

4. In sunny weather some solar heating may warm the air mass and upper grain surfaces, thus producing a drying effect.

5. Air can be encouraged to pass through certain areas of the bin by covering portions of the grain mass surface.

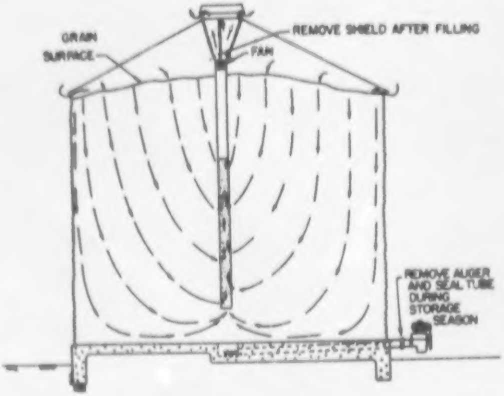
Disadvantages of Downdraft (pulling)

1. If heating has occurred, warm air is drawn down around the ducts producing condensation in the cold grain around the ducts. This could result in sprouting of the grain blocking off the duct.

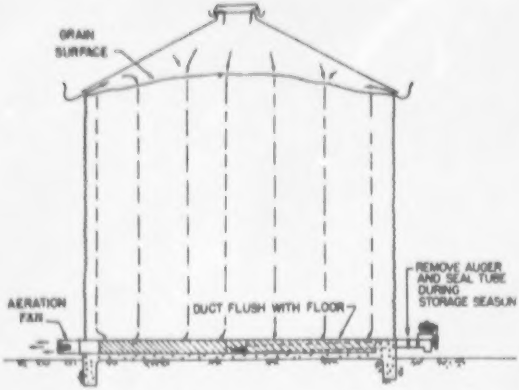
2. Damp areas deep in the grain are likely to cause problems and movement of the air around the problem mass.
3. Any fan heat that may be generated is wasted.
4. It is impractical to add heat to control the relative humidity of the entering air.
5. When warm grain is loaded on top of cool grain the cold layer is rewarmed.

Farm Bin Aeration

This bin contains a vertical duct aerator used for round bins. This type is used in bins containing less than 5,000 bushels.

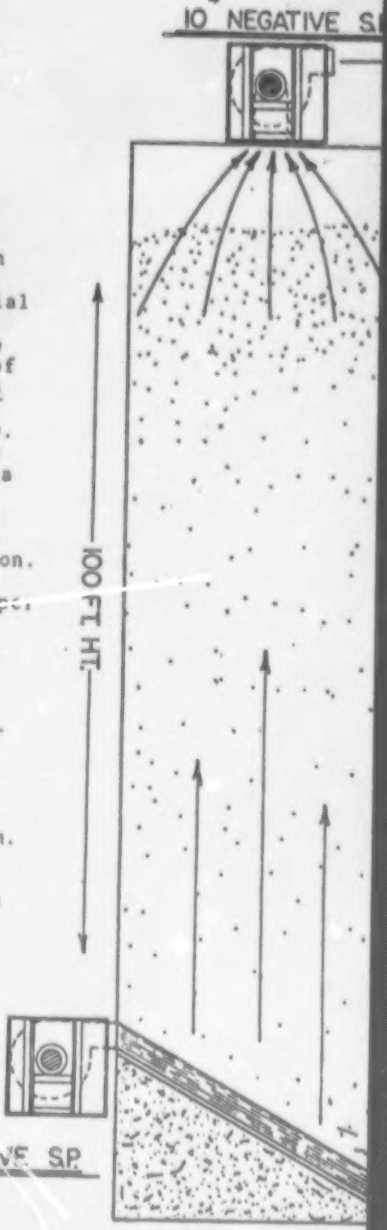

GRAIN SURFACE
REMOVE SHIELD AFTER FILLING
FAN
REMOVE AUGER AND SEAL TUBE DURING STORAGE SEASON

This bin contains a horizontal duct aeration system which is used for round bins. This type is used in bins containing over 5,000 bushels.

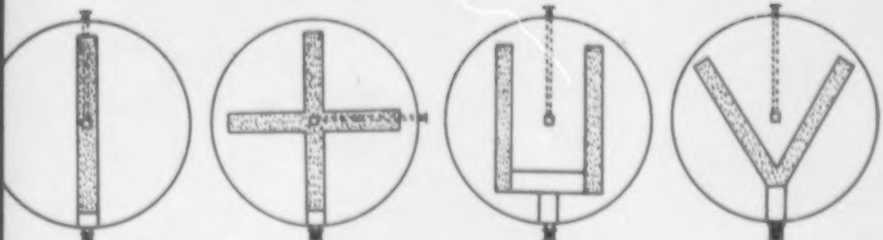

GRAIN SURFACE
AERATION FAN
DUCT FLUSH WITH FLOOR
REMOVE AUGER AND SEAL TUBE DURING STORAGE SEASON

PUSH-PULL AERATION SYSTEM

Aeration systems for extremely tall structures many times require fans to produce high static pressures which are nearly impractical. Static pressures which are "too high" can be divided between two fans in a "Push-Pull" system. For example, 20" of Static Pressure is required to force 1/5 CFM per bushel through 100' of corn. Two fans in a "Push-Pull system each working against 10" S.P. could do the job. The suction fan at the top of the bin could develop a negative 10" S.P. and the pressure fan at the bottom could develop a positive 10" S.P., making the pressure differential between the top and bottom of the grain the required 20" S.P. Each fan must be capable of delivering the total amount of air needed, since the same air must pass through both fans. Do not add the fan capacities together to get total airflow. Due to the fact that most bins will have an "air leak" at the top in the form of a downspout, etc., the top fan usually is engineered to work against approximately 1/3 of the total S.P. and the bottom fan 2/3. This can vary with each installation. Plugging these "airleaks" is a great aid in helping the top fan to generate a proper pressure. This system should only be applied to bins that have the structural capability to withstand the static pressures involved. When properly employed this "Push-Pull" system can save considerable HP. For example, if when considering our figures above 4750 total CFM would be needed, a 40 HP Centrifugal fan would be required in a single fan system, whereas two 10 HP fans would do the job when used in a "Push-Pull" system. In most instances a slightly larger fan is used at the bottom than at the top because it is more practical, but this is in the end up to the person who designs the aeration system.



Aeration Duct Patterns



(a) (b) (c) (d)

The system in Figure (b) provides the best air distribution pattern and gives a higher concentration of airflow at the center, often a trouble spot. This pattern would be desirable for bin diameters of 27 to 40 feet.

Selecting Equipment

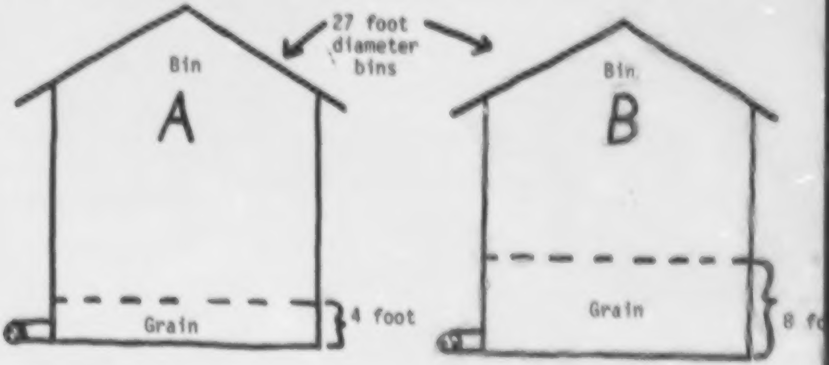
Fan and motor units are selected on the basis of air volume (cfm) at a certain static pressure (airflow resistance that fan operates against; inches of water). The volume of air is determined by multiplying the desired airflow rate per bushel (cfm/bu) by the number of bushels stored. Static pressure is figured according to the type and depth of grain.

Aeration Measurements

Tackling the second problem found in aeration is understanding the true facts about a couple of terms. Static pressure is the resistance to airflow or air movement through grain. It is measured in inches of water. Static pressure increases as the depth of grain increases. Other factors that can also cause an increase is dirty grain and different kinds of grain. The smaller the kernels are the tighter they fit together. Consequently, wheat will have a higher static pressure than corn and milo will have higher static pressures than soybeans.

The second term is cubic feet per minute. (cfm) What is generally meant, however, is cubic feet per minute per bushel. cfm is a measure of airflow in terms of volume under specific conditions. When buying aeration equipment do not buy horsepower or diameter size. By cfm's of air. You want the equipment to aerate the grain so purchase the maximum cubic feet per minute capacity for the same dollars.

An interesting relationship exists between the depth of grain and the number of total bushels of grain. Also, horsepower requirements do not double as static pressure doubles or by doubling the cfm's required. Figure V is a comparison of grain depth and how it affects the cfm, air velocity, static pressure and horsepower requirements. There are two key points to remember in figure V. First the bin diameter is the same and both aeration fans are engineered and designed to deliver 10 cfm per bushel of grain.

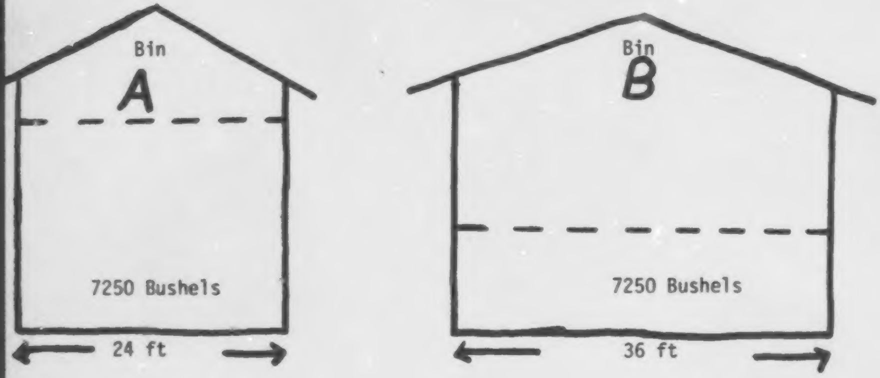


	Bin A	Bin B
Total Bushels	1,832	3,664
Total Air Flow in cubic feet/min.	18,320	36,640
Required Air Velocity feet/sec.	32	64
Static Pressure inches of water	2.3	13.9
Horsepower Required	13	160

FIGURE V

You will note the example in Figure V shows that some values merely double as the grain depth doubles. However, static pressure is a 6 fold increase and horsepower requirements are a 12 fold increase. In fact a 160 horsepower fan is not available by any manufacturer.

In Figure VI we will compare aerating the same number of bushels but in different size grain bins. Again the grain depth will be different due to the difference in bin diameters. The point is, in aeration, depth of grain is the critical issue to concern yourself with. A larger diameter bin can hold more bushels at the same depth.



	Bin A	Bin B
Grain Depth	20 ft.	9 ft.
Static Pressure @ 1/7 cfm/bu.	1.25 in.	.36 in.

FIGURE VI

Aeration Fans

Aeration fans cannot be measured in horsepower alone. The size of the fan and the amount of air it can deliver at certain static pressures determine the true capacity of a fan. (See Figure VII for some comparisons.)

Fans are constructued either as axial fans - like airplane propellers, or as centrigugal fans - like furnace fans. Each fan has definite

TYPICAL AIR DELIVERIES OF FANS USED ON DRYING BINS

HORSEPOWER AND DIAMETER (IN INCHES)	AIR DELIVERY AT STATIC PRESSURE OF: 1 IN.	2 IN.	3 IN.	4 IN.
3 HP 16 -------------	6,160	5,500	4,850	3,925
5 HP 20 -------------	9,350	8,450	7,380	6,090
5 HP 24 -------------	11,100	10,000	8,700	6,910
7½ HP 20 ------------	11,900	10,800	9,700	8,500
7½ HP 24 ------------	13,600	12,500	10,000	9,100
10 HP 36 -------------	26,000	22,500	18,000	10,500

FIGURE VII

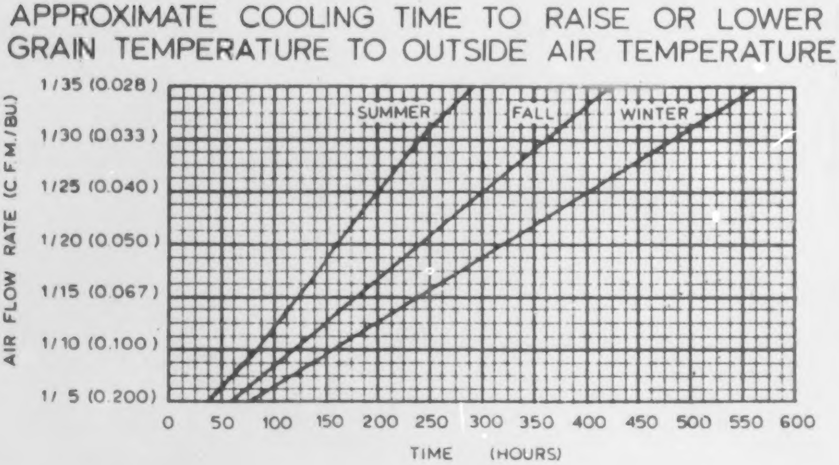
advantages. Listed below are the advantages of each fan type.

Axial Fan	Centrifugal Fan
1. Air moves parallel to fan axis.	1. Air moves perpenicular to the fan axis.
2. Used in low static pressure systems.	2. Used in higher static pressure systems.
3. Will move a high volume of air.	3. Quieter operation for same air delivery.
4. Inexpensive to purchase initially.	4. No unstable operating turbulance.

Aeration fans are referred to as delivering a specific volume of air per bushel when a bin is completely filled. If, however, the bin is not full, you deliver more cfm's per bushel because there are less total bushels. In effect then you can nearly double your cfm's per bushel by cutting in half your depth of grain. (An interesting note, you do not cut your static pressure in half but may fact reduce it by 75-80%) So an aeration fan will be designed to deliver 1/30, 1/25, 1/20, 1/15, 1/10, 1/7, 1/2 or up to 1 cfm per bushel. That means when every fan is in operation on the bin and the bin is filled with grain the system is designed to deliver that many cfm's to every bushel in the bin.

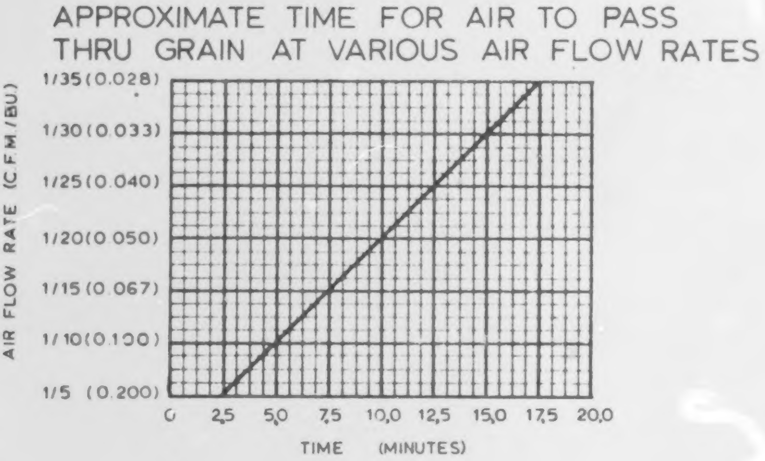
To compute total cfm delivered and passed through the storage bin, simply multiply the total bushels capacity times the rated delivery. The entire process of aeration is designed to cool grain. As new grain is delivered to the bin two choices exist. You must dry the grain or cool the grain. A good parallel relationship to remember for cooling or drying the grain is that a 2% moisture reduction has the same effect as cooling the grain 13 degrees. Also cooling the grain 13 degrees will have the same effect as lowering the moisture 2% points.

The time required to cool grain and to pass air completely through the grain is displayed in Figure VIII and Figure IX.



APPROXIMATE COOLING TIME TO RAISE OR LOWER GRAIN TEMPERATURE TO OUTSIDE AIR TEMPERATURE

FIGURE VIII



APPROXIMATE TIME FOR AIR TO PASS THRU GRAIN AT VARIOUS AIR FLOW RATES

FIGURE IX

GRAIN STATIC PRESSURE CHART
— FOR —
HIGH MOISTURE SHELLED CORN

STATIC PRESSURE — INCHES OF WATER

GRAIN DEPTH — FEET \ C.F.M. PER BUSHEL	.04	.05	.08	.10	.15	.20	.33	.50	.75	1.0	1.25	1.50	1.75	2.0
150′	5.80	7.70	11.7	20.4										
140′	4.95	6.60	9.90	17.3	35.7									
130′	4.20	5.60	8.35	14.5	25.3	39.0								
120′	3.55	4.70	6.85	12.0	20.3	32.4								
110′	3.00	3.80	5.70	9.80	15.7	24.7								
100′	2.45	3.15	4.60	7.80	12.6	20.5	40.5							
90′	1.95	2.50	3.60	6.00	9.60	15.8	31.0							
80′	1.55	1.95	2.80	4.60	7.30	11.8	22.8							
70′	1.15	1.45	2.10	3.35	5.35	8.60	17.0	34.6						
60′	0.80	1.05	1.50	2.35	3.70	5.90	11.7	21.6	38.7					
50′	0.55	0.70	1.05	1.55	2.38	3.80	7.50	13.5	25.5	39.7	56.5	75.0		
45′	0.43	0.57	0.85	1.20	1.89	3.04	6.00	10.3	18.4	29.7	44.1	58.5		
40′	0.31	0.44	0.65	0.95	1.40	2.25	4.50	7.60	14.4	21.0	32.2	43.2	52.6	70.8
35′	0.25	0.34	0.53	0.70	1.08	1.73	3.35	5.55	9.45	17.5	22.0	30.5	38.5	47.3
30′	0.19	0.24	0.41	0.55	0.75	1.20	2.35	3.95	7.65	11.3	15.3	19.8	26.1	32.4
25′		0.18	0.29	0.39	0.56	0.92	1.68	2.62	4.87	6.75	9.75	12.8	16.3	20.0
20′		0.12	0.16	0.22	0.37	0.63	1.00	1.60	2.16	4.00	5.40	7.20	9.60	10.8
15′				0.14	0.23	0.37	0.60	0.95	1.34	2.40	3.00	3.94	4.27	5.40
10′				0.06	0.08	0.11	0.20	0.33	0.52	0.77	1.05	1.27	1.80	1.95
5′							0.05	0.07	0.12	0.17	0.21	0.26	0.32	0.39

CHART I

GRAIN STATIC PRESSURE CHART
— FOR —
HIGH MOISTURE BEANS

STATIC PRESSURE — INCHES OF WATER

GRAIN DEPTH — FEET	.04	.05	.08	.10	.15	.20	.33	.50	.75	1.0	1.25	1.50	1.75	2.0
150′	5.00	6.25	10.0	14.3	27.0	38.4								
140′	4.25	5.50	8.50	12.3	20.0	31.5								
130′	3.75	4.75	7.00	10.3	16.8	27.2								
120′	3.00	4.00	5.75	8.75	13.8	22.0	47.0							
110′	2.50	3.25	4.75	7.25	11.3	18.0	37.0							
100′	2.00	2.75	3.75	5.75	8.75	14.6	27.8							
90′	1.75	2.25	3.00	4.75	7.00	11.3	22.9	40.5						
80′	1.25	1.75	2.25	3.75	5.25	8.75	17.3	30.7						
70′	1.02	1.25	1.75	2.75	4.00	6.25	12.0	21.6	41.0					
60′	0.87	0.94	1.25	1.75	2.75	4.25	8.25	15.8	27.0	43.3	60.4			
50′	0.52	0.65	1.05	1.25	2.00	2.75	5.50	9.75	17.7	27.8	39.0	50.3		
45′	0.43	0.54	0.91	1.08	1.50	2.25	4.25	7.25	13.2	21.6	29.8	38.5	49.3	
40′	0.34	0.41	0.69	0.84	1.25	1.75	3.50	5.50	10.3	16.8	22.2	28.9	35.4	43.7
35′	0.25	0.32	0.48	0.71	1.00	1.25	2.50	4.00	7.35	12.0	15.3	20.5	25.8	31.0
30′	0.19	0.22	0.38	0.49	0.75	1.00	1.75	2.75	5.40	7.50	10.6	13.5	17.6	21.6
25′		0.18	0.26	0.33	0.51	0.75	1.25	2.00	3.30	4.75	6.75	8.85	10.8	13.9
20′			0.17	0.20	0.32	0.36	0.75	1.25	1.82	2.75	4.05	5.10	6.60	7.80
15′				0.11	0.18	0.24	0.40	0.75	1.04	1.75	1.98	2.70	3.15	3.83
10′					0.08	0.10	0.18	0.35	0.41	.75	0.78	0.90	1.20	1.41
5′						0.03	0.04	0.08	0.10	0.14	0.17	0.21	0.25	0.29

C.F.M. PER BUSHEL

CHART II

GRAIN STATIC PRESSURE CHART
— FOR —
HIGH MOISTURE MILO

STATIC PRESSURE—INCHES OF WATER

GRAIN DEPTH—FEET	.04	.05	.08	.10	.15	.20	.33	.50	.75	1.0	1.25	1.50	1.75	2.0
150′	19.3	24.8	41.2											
140′	16.8	21.0	35.8	47.0										
130′	14.3	18.0	31.2	39.0										
120′	12.0	15.3	21.6	32.4										
110′	10.0	12.8	18.0	28.0	41.4									
100′	8.25	10.6	14.8	22.5	34.5	49.5								
90′	6.50	8.25	11.8	18.0	28.4	38.4								
80′	5.00	6.50	9.00	14.0	21.0	28.2								
70′	3.75	5.00	6.75	10.8	15.8	22.6	43.7							
60′	2.75	3.75	5.00	7.75	11.6	17.6	29.8	50.5						
50′	1.75	2.50	3.25	5.25	7.75	11.6	19.6	32.7						
45′	1.50	2.00	2.75	4.25	6.25	8.75	15.6	27.0	42.5					
40′	1.25	1.50	2.25	3.25	4.75	6.50	13.3	20.6	33.3	45.5				
35′	0.94	1.25	1.75	2.50	3.75	4.75	9.75	15.8	24.7	35.8	47.2			
30′	0.77	0.88	1.25	1.75	2.75	3.50	7.00	10.6	18.5	25.2	32.9	41.8	56.4	
25′	0.53	0.64	0.86	1.25	1.75	2.50	4.50	7.00	11.6	16.5	22.5	27.4	33.4	46.8
20′		0.42	0.50	0.75	1.25	1.50	3.00	4.50	6.75	10.0	13.2	16.8	20.4	24.0
15′			0.37	0.29	0.75	0.90	1.56	2.60	3.82	5.18	6.95	9.00	10.6	12.6
10′					0.29	0.41	0.75	1.05	1.72	2.25	2.75	3.45	4.20	4.87
5′						0.11	0.17	0.25	0.39	0.53	0.68	0.89	1.02	1.13

C.F.M. PER BUSHEL

CHART III

GRAIN STATIC PRESSURE CHART
— FOR —
HIGH MOISTURE WHEAT

GRAIN DEPTH — FEET	STATIC PRESSURE — INCHES OF WATER													
150′	21.8	30.0	52.0											
140′	18.8	25.2	44.0											
130′	16.3	20.8	36.0											
120′	14.0	17.6	31.0	40.3										
110′	11.8	14.8	24.8	33.0	51.2									
100′	9.75	12.3	20.1	27.0	40.5									
90′	8.00	9.75	16.2	20.8	35.2	47.3								
80′	6.25	7.75	[illegible].9	16.0	26.5	34.8								
70′	4.75	5.75	7.75	12.3	18.6	26.3	51.0							
60′	3.50	4.25	5.75	9.00	12.8	20.0	36.0	60.7						
50′	2.25	3.25	4.00	6.00	8.50	13.6	22.5	40.2						
45′	1.75	2.50	3.25	5.00	7.00	10.6	18.3	32.8	50.5					
40′	1.25	2.00	2.75	4.00	5.50	8.25	15.8	23.4	40.3	50.0				
35′	1.00	1.50	2.00	3.00	4.25	6.00	11.8	19.0	30.0	44.1	60.5			
30′	.75	1.00	1.50	2.25	3.25	4.50	7.75	12.2	22.0	30.2	40.1	54.0		
25′	0.67	.75	1.00	1.50	2.25	3.00	5.00	8.00	14.1	21.6	26.6	33.4	43.3	48.7
20′		0.54	0.73	0.99	1.25	2.00	3.25	5.00	8.10	9.50	15.9	20.1	24.9	28.5
15′				0.56	.75	1.00	2.00	3.00	4.70	5.25	8.35	10.8	8.55	15.2
10′					0.36	0.48	.75	1.25	1.90	2.75	3.53	4.05	5.25	5.88
5′						0.14	0.20	0.30	0.46	0.62	0.82	0.98	1.14	1.35
	.04	.05	.08	.10	.15	.20	.33	.50	.75	1.0	1.25	1.50	1.75	2.0

C.F.M. PER BUSHEL

CHART IV

High Moisture Storage

Recent developments in feeding practices has offered producers new avenues for handling high moisture grain. Grinding high moisture corn, placing it in a bunker silo and letting it ensile is a process used by several commercial feedlots. Energy cost are reduced and the expense of owning a grain dryer has been eliminated.

Air tight storage is promoted by several companies to maintain the feeding value of grain and eliminating field and storage losses. There are some limitations to these air tight system. The greatest disadvantage is the initial purchase price.

Acid treating grain is a widely accepted approach to handling wet grain. Manufactures of the grain preservatives generally use a mixture of digestible acids. Propionic acid and acetic acid constitute the largest percentage of ingredients. Both acids occur naturally in the digestive tracks of livestock so there is no problem with palatability.

The greatest disadvantage to using a chemical preservative is that the grain is limited to use as livestock feed only. Acid treated grain cannot be marketed through regular grain marketing channels. Official USDA grading of acid treated grain gives a Sample grade. The germ of each individual seed has been killed by the acid treatment. The two acids combine with the moisture found in each kernel and also destroys the mold spores found in the grain. By properly treating the high moisture grain it may be stored and used in livestock rations for periods of up to a year.

Summary

Harvesting and conditioning grain must follow the direction dictated by final use. To eliminate excessive field losses the producer must harvest grain at moisture levels above those considered safe for storage. Corn, for example, is harvested between 26-28% to minimize field losses. This leaves the producer four alternatives to condition and handle his grain.

(1) Dry and aerate
(2) Aerate by natural air only
(3) Chemically treat grain with acid preservatives
(4) Store grain as high moisture through ensiling processes

If the producer elects to delay harvest and allow the crop to mature and dry in the field, he can reduce deterioration. For each 15 day period that corn harvest is delayed deterioration of the grain is cut in half. Losses through spoilage and heating are then reduced considerably because the dry matter decomposition is reduced.

Dry matter decomposition or spoilage in corn is doubled for each 2% moisture increase between 20 and 25%. Dry matter decomposition is also doubled each time the airflow rate is cut in half between 2.0 cfm/bu and 0.5 cfm/bu. Dry matter decomposition is the key to long term storage and maintaining quality. A 20 degree increase in outside temperature will also double the decomposition rate for grain above 14% moisture.

To hold wet corn and maintain its quality minimum airflow rates must be used during aeration. As a rule of thumb the following rates and moisture levels may be used to adequately aerate corn.

Moisture above 20% - 3/4 cfm/bushel
Moisture above 22% - 1.5 cfm/bushel
Moisture above 24% - 3 cfm/ bushel

As aeration information is studied some basic values and facts remain the same. Other information is classified as "rules of thumb" or someone has had success using certain techniques. Being able to differentiate between those two categories is important to properly manage an aeration system.

Below are a list of aeration facts that should be considered in designing and operating an aeration system.

1. Aeration should be done on a planned schedule taking into consideration atmospheric conditions.

2. Corn at 18% moisture or above is too wet to attract or absorb moisture from the atmosphere. If corn is over 18% moisture turn the fans on and let them run continuously.

3. Corn at 18% moisture will create a bin relative humidity greater than 90%.

4. Wheat at 13% moisture is in equilibrium or in balance with outside air at 68% relative humidity. Mold and fungus growth will occur at 63% relative humidity.

5. It takes 640 cubic feet of air at 40° F to cool 1 bushel of grain from 80° F down to 40° F.

6. To double the airflow rate in a bin requires twice as much air volume more than twice the air pressure and 4-5 times the horsepower.

CHAPTER V

INSECT AND RODENT CONTROL

CHAPTER OBJECTIVES

After completion of this chapter the student should be able to:

1. Identify insects of stored grain and describe their life cycles.
2. Describe conditions causing insect infestations in stored grain.
3. Learn recommended protectants and fumigants and describe their use and calibrate rates of application.
4. Identify indicators of rodent infestations.
5. Identify problem rodents around grain storage facilities.
6. Develop an insect and rodent program for a grain storage facility.

TEACHING AIDS

1. Pictures of insects secured from Phostoxin Inc.
2. Show grain samples that have been damaged by different insects.
3. Identify live insects under microscopes or magnifying glasses.
4. Tour different grain storage facilities and identify different causes of grain storage insect problems and indicators.
5. Make a set of student self-instruction plastic laminated sheets of fifteen specific stored grain insects. The detailed information on each insect is enclosed in the Appendix and is entitled "Student Self-Instruction Exercises". The student studies one insect each week and takes notes, then at the beginning of a predetermined class takes a short exam over the insect he studied.

SUPPLEMENTAL REFERENCES

1. "Principle Stored Grain Insects of Kansas," picture sheet No. 1, Cooperation Extension Service, Kansas State University, Manhattan.

2. "Stored Grain Insects and the Clean Grain Program," L-30 Revised, Kansas State University, Manhattan.

3. "Grain Auger Calibration for Insecticide Application," MF-469, Kansas State University, Manhattan.

4. "Stored Grain Insect Manual", Crop Production Area, Farmland Industries, Inc., Kansas City, Mo.

5. "Kansas Pesticide Users Handbook."

STUDENT STUDY GUIDE

The following terms and questions should be answered from the Technical and Instructional Material or Supplemental References.

Insect -

Egg -

Larva -

Pupa -

Adult -

Fumigant -

Protectant -

Pathogen -

Insecticide -

Gas Mask -

Self-Contained Breathing Apparatus

Canister -

Domestic Rats -

Anticoagulant baits -

STUDENT QUESTIONS

1. There are over ____________ species of insects in the world of which ______ do damage to stored grain.

2. In the U.S. about ______ bushels of grain sorghum are lost annually due to grain storage insect infestations.

3. The total cummulation dollars lost annually from insects in wheat, corn, and grain sorghum is $______________.

4. List and explain the recognizable signs and indicators of insects:
    a)
    b)
    c)

5. List the six divisions of the animal kingdom.

6. The phylum Arthropoda is divided into two economic classes __________ and ________________, of which ______________ has the greatest number of agriculture pests.

7. List the 3 characteristics of insects:
    a)
    b)
    c)

8. List the 3 characteristics which separate orders of insects:
    a)
    b)
    c)

9. ____________ is the change in shape or form which an insect undergoes from the egg to adult.

10. Define and give an example of simple metamorphosis.

11. Define and give an example of complex metamorphosis.

12. The ____________ and ______________ stages of the life cycle cause the greatest economic damage.

13. Describe the three general classifications of stored grain insects and give examples of each.
    a)

    b)

    c)

14. ____________, ____________, and ___________ are the primary insect pests of grain in the corn belt region.

15. ____________, ____________, ______________, ______________

    ____________, ____________, and ______________ are the primary insect pests of wheat in the Great Plains region.

16. Insect larvae destroy _______ times their own weight in grain each of the 3-4 weeks during their development.

17. Grain weevils cannot reproduce in grain below ______% moisture or a temperature below _____°F.

18. Anytime insect fragments above _____% are found in a load of wheat it may be declared unfit for human consumption.

19. Discuss the function, time of use and chemicals used as grain protectants.

20. Fumigants kill both the ___________ and ___________ stages of insects.

21. List and differentiate between the 3 kinds of grain fumigants.

22. Review the advantages and disadvantages of each form of grain fumigants.

23. Review the characteristics of grain fumigants and become familiar with their penetration, flammability and warning odor.

24. Fumigant Dosage Problem - Show All Work
    How many gallons of fumigant are required @ 4 gallons per 1,000 bushels?
    (1) A wooden bin measuring 40 feet wide by 60 feet long with grain an a average depth of 10 feet. Answer______________

    (2) A round concrete silo measuring 107 feet tall with an 18 feet diameter and the grain is down 10 feet from the top. Answer____________.

25. Become familiar with the procedures for fumigating a bin.

26. List 10 Safety Precautions that should be followed when fumigating grain.
    a)
    b)
    c)
    d)
    e)
    f)
    g)
    h)
    i)
    j)

27. Become familiar with procedures for preventing grain storage insect infestations.

28. One pair of rats will eat about ______lbs of grain and contaminate about ____________ ____________ that much in a year.

29. One pair of mice will eat about ______lbs of grain and contaminate about ____________ ______________ that much in a year.

30. What is the estimated loss per year in the United States by rats? ____

31. Four primary diseases spread by rats are ____________________, ________________________, ________________, ________________.

32. The largest and most common of the domestic rats is the _______.

33. Rodents are characterized by ___________________________________ ____.

34. The _______________ ____________ is the smallest of the domestic rodents.

35. What do rodent signs tell?_____________________________________ ____.

36. How are fresh droppings distinguished from old droppings? ____.

37. What are runways?____.

38. What is a rubmark?____.

39. The __________________rat prefers burrows for nesting and harborage.

40. Small chips of wood or other materials indicate_______________ gnawings.

41. Forces that determine the size of a rodent population at a given time are _________________, _________________, and __________.

42. Man can reduce rodent population and keep them low by permanently eliminating their ________________,____________________ and ________________________.

43. ____________________ ______________________ is the first and foremost requirement for rodent control.

44. How do anticoagulant rodenticides kill?_______________________ ____.

45. Some examples of anticoagulant rodenticides are ________________ ___________________,___________________,____________________, ___________________, _______________________.

46. What is prebaiting?______________________________________
______________________________________.

47. When are traps useful?______________________________________
______________________________________.

48. What two steps must be taken to treat an area or building for ectoparasites?
    a)

    b)

49. Anyone handling dead rodents should wear__________ __________.

50. ____________________ consists of changing structural details to prevent entry of rodents into buildings.

51. Rats and mice spread at least a ______________ different diseases to man and livestock.

52. Control of rodent population can be accomplished by:
    a)

    b)

    c)

53. To be effective, a bait must be ________________.

54. Anticoagulants must be eaten ______________ for ______________ ______________.

55. Anticoagulants are __________ to all ________ ________________ animals.

56. Anticoagulants can be obtained in three forms:
    a)

    b)

    c)

57. Water-soluble anticoagulants are valuable to use with ________ ________________.

58. They are especially effective where ____________ is scarce.

59. ______________ and ______________ on the package should be followed closely.

60. Anticoagulant baits should be placed in ____________ __________ ______________ boxes.

61. Bait stations should be placed in ______________ spots.

62. ____________ is an excellent bait to mix with water-soluable anticoagulants.

63. Traps may be baited with __________, ____________, ____________
___________, ___________ _______ or __________.

64. A No. _____ steel jaw trap may be used instead of a ___________
___________ for rats.

65. ____________ ____________ __________ and ___________ __________
are the gases most often used for rodent control.

66. It is important that all bait stations be checked ____________.

TECHNICAL AND INSTRUCTIONAL MATERIAL

INSECT CONTROL

Introduction

Insects are the largest and most diverse class of animals. There are well over 1,000,000 known species in the world. Insects, second only to moisture, are a major hazard to the safe storage of grains. More than 20 species do damage to stored grain. The estimated annual United States losses from stored grain insects are 60 million bushels of wheat, 234 million bushels of corn and 17 million bushels of grain sorghum. This totals to 311 million bushels of grain. Multiply this times an average of $3.00 per bushel and you come up with $933 million annual loss. I would compare this to watching Chase Manhattan Bank burn to the ground.

Experience has shown that factors favorable for keeping the quality in grain are unfavorable for the development of insects. So, economics if nothing else tells us we should do a better job of recognizing signs, indicators of insects and then controlling them.

1. Sight - One can see insects and the results of their activity.
2. Smell - One should note the destinct odor which results from this activity.
3. Dusts - When moving or turning grain look for excessive dust.

Classification

To acquire a knowledge of insect control, we first need to distinguish between insects and other "critters". The animal kingdom is divided into groups which are further sub-divided according to features that the various forms of life have in common.

The first division is into large groups known as phyla. Phylum is the singular, phyla the plural. There are ten major phyla, nine of these being invertebrates (no backbone). Insects are part of the phylum Arthropoda. Spiders, mites, crayfish and centipedes are also in this large group. More than three-fourths of the total number of species of animal life are Arthropods. Phyla are further broken into classes, then into odor, then family, and finally genus and species. To illustrate this breakdown, let's classify the Red Flown Beetle.

Kingdom - Animal
  Phylum - Arthropoda
    Class - Insects
      Order - Coleoptera
        Family - Tenebrionidae
          Genus - Tribolium
            Species - Castaneum (Herbst)

The class insecta, or insects, contains the greatest number of agricultural pests. Another major class, Arachnida, is composed of spiders, sccrpions, mites and ticks. Spiders are generally beneficial, since they mainly feed on insects. Mites and ticks belong to the order Acarina and are the most important of the Arachnids from an economic standpoint.

Identification

Insects are characterized by the following features:

1. The exoskeleton (shell or outer covering is divided into three body regions; head, thorax and abdomen.
2. Three pairs of legs attached to the thorax.
3. One pair of antennae ("feelers").
4. May have more, none, one or two pair of wings.

There are three key characteristics, along with certain other features, which tend to separate the orders of insects. These are:

1. Type of mouthparts
2. Type of wings
3. Type of metamorphosis

The mouthparts of insects are two principle types; chewing and piercing sucking, although there are special adoptions of these types.

Most insects have two pairs of wings, although there are numerous exceptions. Several of the descriptive terms relating to insects wings need to be defined.

1. Membranous - Thin and transparent.
2. Tegmina - Thickened, leathery forewings (Orthoptera)
3. Hemalytra - Forewings which have a thickened basal portion and a membranous final protion (Hemiptera)
4. Elytra - Thickened, horny or leathery forewings (Coleoptera)
5. Halter - A slender knobbed structure in place of hindwings.

Metamorphosis is the change in shape or form which an insect undergoes from the egg to full-grown adult. These changes in shape or form may be rather gradula or quite spectacular. The two main types of metamorphosis are:

1. Simple, incomplete or gradual - The stages of this life cycle are egg, nymph and adult. A grasshopper is an insect which has this type of metamorphosis.

2. Complex or complete - The stages of this life cycle are egg, larva, pupa and adult. Most grain storage insects have this type of metamorphosis.

Often the nymph and the larva are the forms which cause the greatest economic damage. Both of these immature forms go through several molts as they feed and grow. Each stage between molts is called an instar.

Damages

Normally grain is thought to be free of insects as it is harvested, since all major insect infestations occur after the grain is placed in storage. The stored grains that are most often infested by insects are: wheat, oats, shelled corn, barley, rye and grain sorghum. Soybeans are seldom infested.

There are more than 20 insect species found in stored grains, but only about half of them are of major importance. Stored grain insects are broken down into three general classifications.

1. Primary - those that attack whole grain kernels and complete their development inside the kernel. Those of importance in regard to the damage they do are: Granary Weevil, Rice Weevil, Lesser Borer Grain and Angoumois Grain Moth. They can live in sound, dry grain.

2. Secondary - those that feed mainly on cracked or broken kernels, or outside of grain kernels. Those of importance in regard to the damage they do are: Indian Meal Moth, Flat Grain Beetle, Saw-toothed Grain Beetle, Cadelle, Confused Flour Beetle and Red Flour Beetle. They can live in sound, dry grain.

3. Fungus-feeding pests - these pests cannot live in sound dry grain. Their presence indicates that grain is going out of condition. Examples of these are Fungus Beetles, mites and psocids.

The insects that attack stored grain are rather general feeders, but some of them definitely prefer certain grains. In the corn belt, six species are responsible for 98% of the damage to stored, shelled corn. The Saw-Toothed Grain Beetle, the Flat Grain Beetle and the Red Flour Beetle are the major offenders. The other three are the Foreign Grain Beetle, the Larger Black Flour Beetle and the Hairy Fungus Beetle. Farther south, the Rice Weevil, through field infestation, often is the most prevalent in stored grain.

In the Great Plains wheat region, seven species constitute 90% of the problems of insects in stored wheat: the Flat Grain Beetle, Saw-Toothed Grain Beetle, Lesser Grain Borer, Red Flour Beetle, Long-Headed Flour Beetle, Cadelle and the Rice Weevil.

North	South	East
Flat Grain Beetle	Lesser Grain Borer	Angoumous Moth
Saw-Toothed Beetle	Rice Weevil	Flat Grain Beetle
	Angoumous Moth	Rice Weevil

The moths that attack grain (and seeds) are not among the most abundant, generally. They do occasionally appear in tremendous numbers on the surface of stored grain. Their caterpillars spin webs that mat the kernels together. The Indian Meal Moth is the most common and inhabits all kinds of cereals. The Almond Moth is more common to seed stores and houses.

Grain insects devour at least their own weight each week. Their larvae destroy many times their own weight each of the 3 to 4 weeks they are developing. Insect infestations frequently cause grain to heat. Musty odors may result. Deterioration and rotting of grain may be caused by the translocation of water vapor from the heated area to the cooler (usually surface) grain. Insect eggs are not ground up during the processing of grain.

The insect pests of stored grain depend on their food supply for water. Low moisture grain is unfavorable for their development. True grain weevils can not breed in grain with moisture under 9%. Their activity is greatly restricted unless the moisture is above 11%. Insect activity is also related to temperature. No activity of consequence is found under 40° F. Little is usually evident up to 60° F., but at 80° F. on up, the reproduction rate is multiplied at increasing rates.

The 1952 Yearbook of Agriculture Insects suggests that most grains in a Nebraska-like climate can be stored over winter in relative safety if moisture is under 13% and if fumigation is practiced as recommended. Soybeans, due to their high oil content, are more difficult to store and moisture content should not exceed 11% for long-timed storage.

Damage grain, cracked kernels, chaff and other foreign material, particularly "fines", not only provide habitat and food for insects, but also interfere with the beneficial air movement in storage. Grains naturally give off heat and moisture through respiration. Any reduction in "venting" can contribute to spoilage. Cleaning of grain can best and most efficiently be done at the harvesting machine. Broken or trashy grain may require cleaning to place it into a storable condition.

Optimum air movement for respiration of grains is plus 80° F. and minus 60% relative humidity.

Federal grain grading standards provide that 5 insects per quart sample may be classified as weevily. Recent Pure Food & Drug Administration rulings provide that a carload may be declared unfit for human consumption any time evidence of insect, rodent, chemical, bird, fungi or bacterial infestation is present above one percent.

This hard live approach to contamination is the result of sophisticated medical studies showing that numerous human health hazards are transmitted through the previously listed contaminants. Many variations occur in this method of disease transmission, which is called obligatory or cyclic, because the disease organism (Pathogen) is dependent on a host for its continued natural transmission.

Control

While the methods used for controlling insects infesting farmers grain bins and elevators differ somewhat from those used for the control of the same insects in mills, warehouses, retail stores, and dwellings, the most effective means of preventing damage is the same. In all cases this consists in keeping the premises as clean as possible. This means the gathering up and removal of all refuse grain, seeds, grain products, flour, meal, or other material in which the insects breed, thoroughly cleaning the bins, storerooms, mills, or warehouses at periods of the year when they can be emptied; the carrying over from year to year of as little material as possible; and the careful inspection of all material when brought in for storage or processing. When bins, mills, seed houses, or warehouses are built, the insect problem should be given due consideration, and the construction should be such that the stored products will be kept dry, that cracks and crevices are reduced to the minimum, and that the most effective control measures may be applied at the minimum expenditure of effort and expense. Provision should be made in mills for heat-treating, and bins and storehouses should be made sufficiently tight for effective fumigation. Any building where grains or grain products or seeds are held in storage for some time is practically sure to become infested sooner or later and to require treatment. Inaccessible dead spaces in bins and storerooms, where wastes collect, may be teated with miscible oil, 1 gallon, lye, 1/2 pound, and water, 9 gallons. Screening and waste grain of all kinds should be kept away from mills and storehouses. Since insect damage is greater the higher the moisture content of the grain, storage in damp situations should be avoided. Storage of grain in hermetically sealed underground vaults eventually kills stored-products pests through oxygen starvation.

Destruction by Heat and Cold

The heat-treatment has given good results for treating mills, retail stores, or storerooms in dwellings, as it can usually be applied so that practically all insects are killed; and the expense of treatment is lower than that of any other method. The heat-treatment should be used during the period when the outside temperature is high. This treatment can seldom be used in elevators, farmers' bins, or other small storages, In most buildings the heating system used in the winter will be sufficient to maintain temperatures high enough to kill the insect life in the mills during the summer, when outside temperatures are from 90° to 100° F. and little wind is blowing. Repeated tests with this method have shown that, in mills of family tight construction under the above conditions, it is possible to maintain temperatures from 120 to 150° F, for several hours and that such temperatures are fatal to all insects exposed to them. Owing to the construction of the buildings or the lack of heating facilities, this method cannot always be applied effectively. In most mills, however, the expense of installing sufficient heating units will not be so great as that of annually fumigating with hydrogen cyanide gas or some other fumigant. Heat is not satisfactory for the treatment of nuts and dried fruits. Heat may be used for seeds intended for planting, if the exposure is not over 8 hours, the temperature not higher than 135° F, and the seeds reasonably dry (containing not more than 12 percent moisture).

If there are large quantities of seeds to be treated, it will be found difficult to raise the temperature sufficiently in the interior of the mass without exposing the outer layers too long or to too high temperature. Under such conditions it is better to use a heat-treating machine. There are a number of heat-treating machines through which grain may be passed as it is moved from one bin to another and be subjected during its passage through the machine to temperatures of 130 to 140° F. for 30 minutes. Such machines are frequently very valuable, particularly for use in elevators or mills, where conditions are such that frequent infestations are [illegible] to occur from the waste grain about the building and from grain being brought in. Where outside winter temperatures go as low as 20° below zero, opening the building to this temperature will kill most grain-infesting insects. In elevators and mill storage bins it is often possible to keep down insect damage by frequently moving the grain from one bin to another, as the insects do not thrive and multiply rapidly in grain that is frequently disturbed.

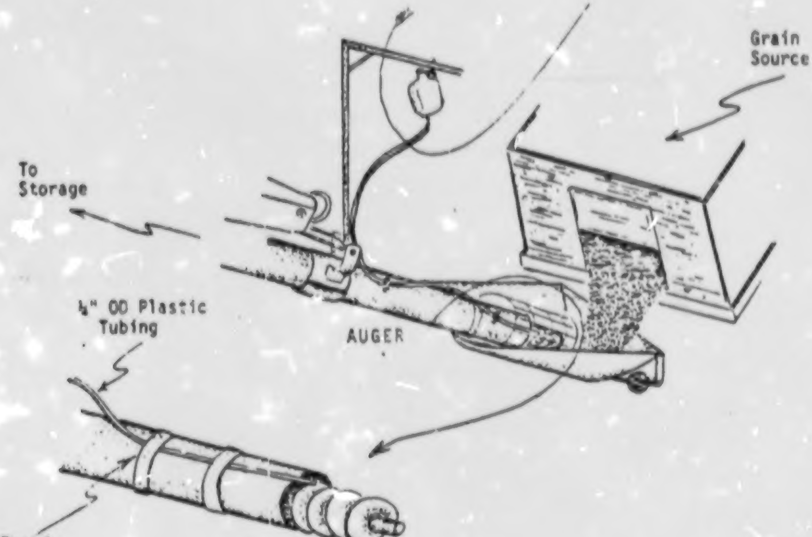
Using Grain Protectants

Protectants are those insecticides which are mixed with grain at harvest time, or when it is turned, to prevent insects from entering the grain. They do not control infestations already in the grain. Protectants are also used when cleaning bins and elevator premises since these areas harbor insects who move into new grain storage from their hiding places. Malathion, 57% premium grade is one example of a protectant insecticide.

Protectants may be easily applied while putting grain in the farm grainery. A simple "drip on" applicator for metering malathion or synergized pyrethrins into grain as it goes into the farm grain bin can be built for about $7. The device, designed by entomologist James K. Quinlan of USDA's Science and Education Administration, is an alternative to expensive and hard-to-calibrate spray equipment.

The gravity feed applicator is used as grain is unloaded from a truck into the hopper of a portable auger. The tubing is taped horizontally along the auger tube at the pick-up end, with the end of the tubing extending 1/2 inch beyond the end of the auger tube so the insecticide flows directly into the grain. The plastic jug is suspended from the top of the bin. This is shown in operation in Diagram 1. The following is needed to build the "drip-on" applicator.

1 plastic jug, 128 ounce
1 lock nut, 1/4" 18 pipe thread (PT)
2 washers, 1/2"
1 rubber gasket, 1/4"
1 pipe reducer, 1/4" 18 PT x 1/8" 27 PT
1 shut-off cock, 1/8" 27 PT x 1/8" 27 PT
1 pipe coupling, 1/8" 27 PT x 1/8" 27 PT
1 angle needle valve, 1/8" 27 PT x 1/4" OD
Polyethylene tubing, 8' x 1/4" OD


Grain
Source
To
Storage
AUGER
¼" OD Plastic
Tubing
Taped

DETAIL OF AUGER
Showing placement of tubing

Diagram 1

This applicator is built by fitting two brass valves and polyethyene tubing in sequence to an opening in the bottom of a plastic milk jug. The fittings should be readily obtainable at a plumbing supply shop.

The upper shut-off cock on the jug serves as the on-off valve, while the lower needle valve regulates the amount of insecticide flowing through the plastic tubing. The needle valve is first calibrated to the desired flow for the amount of grain being delivered. It then can be kept at the same setting, without the need for fine adjusting each time flow is turned on. See Diagram 2 for an enlarged drawing of this applicator.

Grain protectants are usually applied at the rate of 3 to 5 gallons per 1,000 bushels. Two hundred bushels can be treated at the 5 gallon per 1,000 bushel rate with 3.2 ounces of 57 percent malathion emulsifiable concentrate mixed with 1 gallon of water.

Using Grain Fumigants.

Fumigants are those insecticides which kill insects, both larvae and adults, in infected grain. Fumigants are three types: (1) gaseous, (2) liquid, and (3) solid. Regardless of type or form applied most become heavier-than-air gas, which is poisonous to warm blooded animals, people, as well as insects.

Applicators must be aware of the dangers of breathing the fumes of fumigants and of absorption into the body when the fumigant contacts the skin. Gloves, aprons, boots and respiratory protection (gas mask or other) is a must. Careless applicators may have their life shortened because of undue exposure to fumigants.

If you (or anyone else) can smell a fumigant, you are exposed to a level that could be harmful if you breath that level for an hour or more. Remember, too, that some fumigants as methyl bromide and phosphine (its garlic like odor may not always be present) are odorless. Waiting until you smell a fumigant may be hazardous to your health.

How much is dangerous? One cupful (eight fluid ounces) of a liquid fumigant evaporated and mixed into the air in a room 200 feet x 100 feet puts that air at the maximum safe level (20 ppm) for a person to breath 40 hours a week. For phosphine and HCN the level is much lower. (0.3 ppm and 10 ppm respectively).

Since all of the fumigants are poisonous and enter mainly through the respiratory tract, special canister type respirators are required. Fumigation, therefore, should be done by an experienced, trained operator.

(1) Gaseous forms are those fumigants which are in the gas phase at normal room temperatures. These are expecially adapted for use by the recirculation or forced distribution method. (Methyl bromide - liquid hydrocyanic acid.

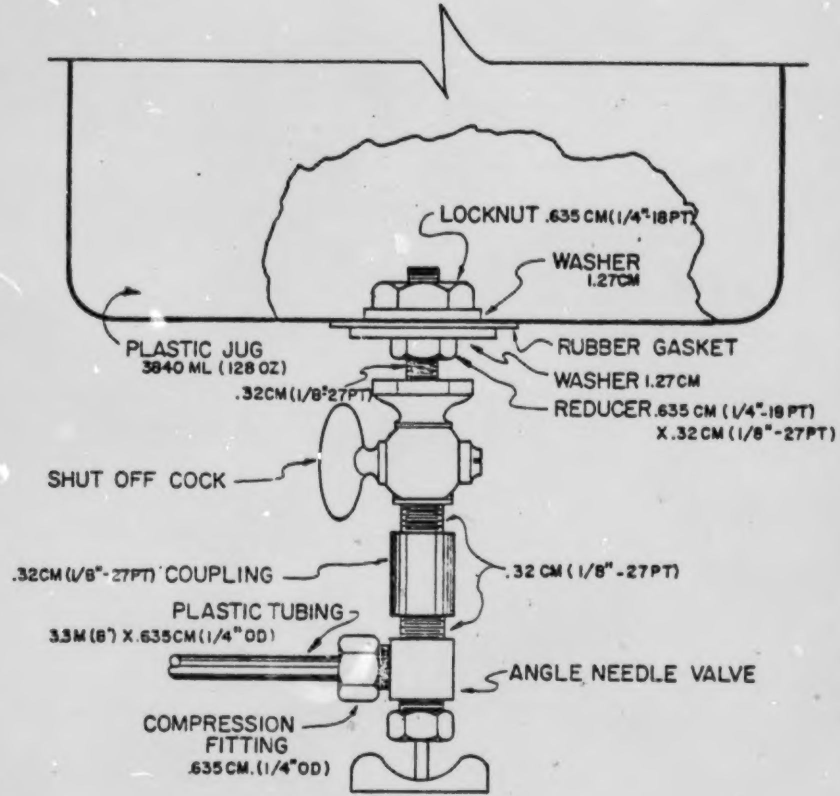

LOCKNUT .635 CM (1/4"-18PT)
WASHER 1.27CM
PLASTIC JUG 3840 ML (128 OZ)
RUBBER GASKET
WASHER 1.27CM
.32CM (1/8"-27PT)
REDUCER .635 CM (1/4"-18 PT) X .32 CM (1/8"-27PT)
SHUT OFF COCK
.32CM (1/8"-27PT) COUPLING
.32 CM (1/8"-27PT)
PLASTIC TUBING
3.3M (8') X .635CM (1/4" OD)
ANGLE NEEDLE VALVE
COMPRESSION FITTING
.635CM. (1/4" OD)

Diagram 2

Advantages:

a. Toxic to most pests
b. Can be applied by various methods
c. Easy to apply without disturbing the commodity
d. Penetrate structures, commodities and equipment
e. Readily available and economical
f. Easy to apply and safe to handle
g. Can be used where fumigant tolerances may be exceeded
h. Sealed building not as essential as for fumigants
i. Effective against flying insects such as moths and flies

Disadvantages:

a. Toxic to humans
b. Required trained applicators
c. Target area or commodity must be enclosed
d. May injure seed germination
e. Temperature requirements may be hard to meet, especially in northern climates.
f. Will not penetrate commodities in concentrations lethal to target pests
g. Resin strips cannot be used in plant areas where food is exposed

(2) Liquids are those fumigants which are normally liquids but vaporize rapidly when exposed to air at room temperature or higher. There are many formulations of liquid fumigants, but two basic mixtures...3:1 or 3 parts ethylene dichloride and 1 part carbon tetrachloride; 80-20 or 4 parts of carbon tetrachloride and 1 part of carbon bisulphide. There can be various percentages of various compounds added for various reasons, or compounds substituted in whole or part for one of the components of the basic mixture.

Some are added to give better kill on the surface; as an irritant or warning gas; added toxicant and warning gas; or increase the toxicity of the mixture.

A basic difference in the two formulations use, is that the 80-20 is more efficient in cooler grain, because it has rapid killing power and can be used in more loosely constructed storages. The 3:1 is a rather slow killer, as it vaporizes more slowly and is used in tight storages. It has, therefore, a longer post-fumigation protection period, before refumigation would become necessary.

Advantages:

a. Usually provide a deposit on surface
b. Can be easily directed onto surface for treatment
c. Easy to store, transport, and handle
d. Adaptable for use in many kinds of equipment

Disadvantages:

a. May be hazardous to use around electrical outlets (water and oil sprays)
b. May damage or stain wallpaper, varnish, and many fabrics (water or oil sprays)
c. Require agitation during application (wettable powders and emulsions)
d. May be hazardous around open flames (oil sprays)
e. May make floors slippery (oil sprays)
f. May damage or etch asphalt, plastic tile, or rubber products (oil sprays)
g. May damage living plants (oil sprays)

(3) Solids are those fumigants which are normally in a solid state and give off a toxic gas on exposure to air. These are usually applied to the grain stream as it enters the bin. (granualar calcium cyanide) Phostoxin is a tablet form which, in the presence of moisture in the air, decomposes rapidly, giving off free phosphine gas. The gas is colorless, heavier than air, with unpleasant odor. It is very toxic, explosive and in heavy concentration is highly flammable. It can be self-igniting. To prevent this, an additive is mixed into the tablets.

Advantages:

a. Excellent for crack and crevice treatments
b. May be purchased ready-to-use
c. Usually require only simple and lightweight application equipment
d. Safe for use around electrical equipment

Disadvantages:

a. Drift easily
b. Easily dislodged from treated surface (should not be applied on equipment or above food-contact surfaces)
c. Generally bulky to store

Methods of Fumigation

1. Surface treatment
2. Turning the grain
3. Aeration

Stored grains in tight bins may be fumigated by applying the fumigant as a coarse spray over the top of the grain. The temperature of the grain should be above 65°F., and after application of the fumigant, the bin should be covered with a tarpaulin or plastic sheeting and the exposure continued for at least three days. The operator should make the application from outside the bin and should be protected by a respirator. The following fumigants and dosages have been suggested for tight steel bins. The dosage should be doubled in a wooden bin.

	Small grain	Corn
	Gallons fumigant per 1,000 bu.	
Carbon bisulfide	1.5	2
Carbon Tetracloride	3	5
Carbon tetrachloride-carbon bisulfide (4:1)	2	5
Ethylene dichloride-carbon tetrachloride (3:0)	4	6
Carbon tetrachloride-ethylene dibromide (19:1)	2	5

The carbon bisulfide is highly inflammable, but the others are non-inflammable. Products in paper-lined bags may be fumigated by injecting the proper dosage into the interior of the bag through a pointed-nozzle extension rod. The general methods of fumigating with hydrogen cyanide have already been described. The same methods should be followed in the treatment of warehouses or storerooms where grain insects are causing injury. Hydrogen cyanide cannot be relied upon to penetrate more than a few inches into a mass of seeds, flour, or stored or sacked grain. Modern mills are often piped with copper tubing fitted with nozzles through which liquid hydrogen cyanide can be discharged over the entire mill or directly into the milling machinery. The dosage used is generally 0.5 pound per 1,000 cubic feet although this should be doubled where the mill is not carefully sealed before fumigation. Methyl bromide at 1 pound to 1,000 cubic feet is highly effective in modern tightly sealed mills, where it is best applied through a piping system, and the exposure continued for 16 to 24 hours. This gas, because of its penetrating properties, is the most efficient fumigant for the treatment of bagged commodities in warehouses, where a dosage of 1.5 pounds per 1,000 cubic feet is generally used. Small 1-pound cans of methyl bromide may be used for fumigating small bins or rooms. Chloropicrin is also effective for mill fumigation when applied at 1 pound per 1,000 cubic feet. It may be distributed through a piping system, propelling by methyl chloride, or applied to machinery by sprinkling or evaporation from burlap sacks. Other fumigants which have been used for spot fumigations are mixtures of carbon tetrachloride and acrylonitrile (1-1) or mixtures of carbon tetrachloride, ethylene dichloride, and ethylene dibromide (65-25-5). The efficiency of fumigation of large grain bins, elevators, or mills can be greatly improved by recirculation of the fumigant-air mixture.

Vault fumigation is especially suitable for the treatment of packaged or bagged products. The use of vacuum fumigation aids in the penetration of the fumigant and decreases the exposure necessary to 1 to 3 hours. The following dosages have been suggested for the fumigation of stored products: liquid hydrogen cyanide, 2 pounds; methyl bromide, 4 pounds; ethylene oxide, 1 part, carbon dioxide, 9 parts, at 60 pounds per 1,000 cubic feet. Satisfactory treatments may be made under polyethylene or polyvinyl plastic sheeting.

Calculate Fumigant Dosage

Treating grain with fumigants is not a difficult task. Following the labeled instructions is the primary concern of the individuals doing the fumigating. Secondly, how much insecticide should be used for the amount of grain being treated? All labels provide the dosage rate, frequently, in 1,000 bushels rates or 500 square feet rates. You then need to calculate the total number of bushels or square feet to be treated.

Several formulas can be used to compute the bushels. From experience, or from your warehouse bin chart you will know the number of bushels in each bin. On the other hand, if you have to calculate the volume there are two formulas to use. Both formulas are based on a cubic foot of space holding .8 of a bushel. If the bin is square or rectangle, level the surface and calculate the total volume in bushels.

$$\text{Bushels} = 0.8 \times \text{length (ft.)} \times \text{width (ft.)} \times \text{depth (ft.)}$$

If the bin is round, level the surface and calculate the total volume in bushels.

$$\text{Bushels} = 0.8 \times 3.14 \times \text{radius (ft.)}^2 \times \text{depth (ft.)}$$

or

$$\text{Bushels} = 0.6283 \times \text{diameter (ft.)} \times \text{diameter (ft.)} \times \text{depth (ft.)}$$

Fumigation Procedures:

1. Level the grain in the bin and remove any crust that may have formed. When grain is heaped up, the fumigant material action will be similar to water on a hillside. The fumigant gas material must move down into the grain to be effective.

2. The size, shape and tightness of the storage structure is important. Leaky bins do not retain fumigant. Tight bins will reta killing concentrations for several weeks.

3. The depth of grain in relation to surface area...and the amount of overspace is critical. The deeper the grain to exposed surface area, the smaller the dosage per unit of grain for complete insect mortality. This is why flat storage requires higher dosages than silo-type tanks. When there is a large amount of space over the grain, it is also more difficult to fumigate.

4. The moisture content of grain has profound effect on the efficiency of the fumigant. The higher the moisture, the more fumigant required. As moisture content increases above 12% a proportionally higher dosage is required. If the surface moisture content is 15 to 20%, the grain can hardly be fumigated because the vapor will not penetrate the moist layer. (You

might have to force it with air...if you can re-circulate the gas). The temperature has some effect, but not as critical as is the moisture content.

5. The amount of dockage and/or foreign material also affects fumigation. Wheat with 3% dockage requires twice the dosage that 1% requires. Milo and corn with large amounts of cracked kernels, husks, cob chaff, chaff, weed seeds and other material will require increased dosages for successful fumigation.

6. The method of applying the fumigant is very important. When using a liquid, the best method is to apply it as a coarse spray evenly over the surface of the grain. Uniform distribution of the vapor is important, since the gas tends to go straight down through the grain with little lateral diffusion as it moves.

7. The amount of compaction influences the rate of penetration of the fumigant. Grain in elevators along railroads and highways is subject to continual vibration. Over a length of time, the kernels nestle more closely together, closing air spaces in the grain.

8. The kind of grain affects the efficiency in accordance with the sorption quality. Milo appears to be much more sorptive than wheat. It may be the difference in type of starch that allows penetration of the gas in one grain more than in another.

9. Fumigants vaporize better at temperatures above 65°F, or higher. Avoid windy days to cut down on fumigant loss.

10. A six to eight-inch air space is recommended above the grain surface. If there is a large air space above, cover the grain with a tarpaulin after fumigation.

11. Finally, the nature of the insect population, what they are as a species, age of the grain and whether it is a new or old re-occurring infestation.

A good grain fumigant:
Has low cost per unit of grain.
Should vaporize rapidly...difuse readily.
Should be non-flammable, non-explosive.
Should not impart any objectionable odor to the grain.
Should not affect the commercial grade adversely.
Should not affect baking quality adversely.
Should not affect the viability of the seed.
Should not leave any harmful residue in the grain.

Fumigant Safety Precautions

NEVER LOSE YOUR RESPECT FOR THE DEADLY COMPOUNDS USED IN FUMIGANTS.

CHARACTERISTICS OF SEVERAL GRAIN FUMIGANTS *

Fumigant	Heavier than air	Grain Penetration	Flammability	Warning odor	Germination effect
carbon disulfied	Yes	Good	High	Rotten egg	Depresses
carbon tetrachloride	Yes	Poor	None	Pungent odor	Depresses
ethylene dibromide	Yes	Poor	None	Sweet odor	Depresses
ethylene dichloride	Yes	Good	High	Ether odor	Little
chloropicrin	Yes	Good	None	Tear gas	Depresses
sulfur dioxide	Yes	--	None	Irritating sulfur	Destroys
hydrogen cyanide	No	Fair	High Concentration	Bitter almond	None
methyl bromide	Yes	Good	Little	None	Depresses
aluminum phosphide	Slightly	Good	In Presence Of Moisture	Carbide-like	None

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*Insect Prevention & Control in Farmed Stored Grain. EC[illegible]8-155[illegible] Cooperative Extension Service
Nebraska.

All chemicals used in fumigation are poisonous to human beings, animals and insects. In handling them, all directions given on that product should be followed and every precaution taken. Don't breathe the vapors or spill liquids on skin or clothing.
BE CAREFUL!!!

TOO MANY FUMIGATORS TEND TO BECOME CARELESS WITH CONTINUED USE OF FUMIGANTS.

Apply the fumigant from outside the bin.
Use a canister type gas mask.
Never fumigate alone; always work in pairs.
After fumigation, keep bin closed for 72 hours.
While under fumigation, keep bins locked. Post signs, "DANGER KEEP OUT".
Allow bins to air out completely before entering.

General Preventative Practices

Under our food grain regulations, it is illegal to sell contaminated grain. One important source of contamination is grain insects.

Insects found in stored grains can be destroyed by fumigants and other methods, but pure food standards suggest that the problem be approached from prevention rather than control standpoint. Good preventive practices are much less troublesome and expensive than controlling established insect populations.

Procedures to Follow in Prevention of Stored Grain Insects.

1. Avoid storing grain in buildings that also house hay, straw, livestock or livestock feed (ground). The higher temperatures resulting from hay insulation and animal heat, and the almost constant presence of insects around livestock areas contribute to higher insect populations.

2. Seriously consider using the following bin sanitation practices before storing grain.

    a. Sweep out and destroy all dust, chaff and webs from storage bins. Remove all old feed accumulations, such as old feed sacks.

    b. Apply a residual insecticide spray to walls and floors of the bin areas. Use the latest recommendations for the insecticides to use, and FOLLOW DIRECTIONS CAREFULLY.

    c. Repair any areas around and in the bin where water or snow might blow in on the stored grain.

    d. Remove all old stored grain if possible, if not possible, treat the old stored grains with a recommended insecticide.

3. Before harvesting and at harvesting of grain do the following:

a. Clean out wagons, combines, elevators and any other equipment involved with harvesting where insects may have laid eggs. Feed the first two or three bushels of grain passing through the combine.

b. Avoid storing grain above 12 percent moisture. Grain stored above this amount is a constant source of disease and insect infestation.

c. Avoid storing grain that has a large amount of cracked or broken grains or other inert matter. Grain with a lot of trash in it will readily attract insects.

d. If previous problems have been experiences with stored grain insect pests, treat the newly harvested grain with an insecticide.

(1) Spray insecticide into the grain stream as it goes into storage.

(2) Be sure to use the latest recommended insecticide and FOLLOW DIRECTIONS FOR ITS USE CAREFULLY.

(3) If the above practice is not used, apply a surface treatment to the stored grain. This will prevent Indian meal moth attacks. Use insecticide recommended for this purpose. FOLLOW DIRECTIONS CAREFULLY

Surveying Stored Grains for Insects

Even when the best of preventative practices are used, insects invasion in stored grains may occur. During warm weather stored grain should be inspected every 30 days to determine the presence of any insects.

Procedure:

1. Take the temperature of the stored grain by fastening a thermometer to a stick and inserting it two feet below the grain surface. If insects are present and active, the temperature will be above 60°F. The most favorable temperature for insect activity in stored grains is about 80°F. A less accurate method, but one that will work is to insert a rod in the grain at several locations. By feeling the rod, you can tell if the grain is heating.

2. To inspect for insects, use a grain probe and insert to a depth of at least two feet in the center of the bin. Sift and probe grain through a 12-mesh to the inch screen.

3. One granary weevil or rice weevil per quart of grain sampled indicates fumigation is needed at once.

Insects, especially weevils, can cause grain shrinkage and dockage losses as high as 45 cents per bushel.

Corn will grade weevily on the market, if in one quart of grain:
a. two weevils are found
b. one weevil and ten other grain beetles
c. 25 other beetles

Wheat will grade weevily on the market, if in one quart of grain:
a. two weevils are found
b. one weevil and two other grain beetles
c. three other grain beetles

RODENT DAMAGES AND CONTROL

Rodents and Human Welfare.

Rats and mice have accompanied man to most of the areas of the world he has settled. Historically, they have been responsible for more human illness and deaths than any other group of mammals. They are universally feared and despised, yet man's indifference and carelessness in handling food and refuse have fostered populations of them in such close proximity to his home and work that they are commonly referred to as "domestic" rodents.

Economic Importance

Rats in the human environment cause enormous economic losses. They consume or contaminate vast quantities of food and feed, and they destroy other property, as when they cause fires by gnawing the insulation from electric wires. Many fires of unknown origin must be attributed to rats.

No reliable estimate of the rat population of the United States is available as a basis for calculating these losses, although the figure of one rat for every person has frequently been quoted in literature. If, in consideration of recent improvements in envionmental sanitation and rodent control, this rough estimate used in the past is reduced by one-half, that is, to an estimated rat for each two people, then the U.S. has some 100,000,000 rats. Each rat damages between $1-10 worth of food and other materials per year by gnawing and feeding, and contaminates 5-10 times more. Thus, rats may cost the U.S. between $500,000,000 and $1,000,000,000 annually in terms of direct economic losses.

Rats and mice are continuing problem both on the farm and around the elevator. One pair of rats will eat about 100 pounds of grain in a year and contaminate about 10 times that much with feces and urine. One pair of mice will eat about 10 pounds of grain in a year and also contaminate about 10 times that amount with feces and urine.

We well know that one pair doesn't stay one pair very long. Rats become sexually mature at about three months of age and can produce a litter of 10 newborn every month after that. Mice mature at about two months of age and produce an average of five young every three to four weeks thereafter. Result - a lot of rats and mice in a short time.

Rat Bites

In addition to the annual dollar losses due to rats, there is also the intangible cost of rat-associated injury and illness. Rat bites create a serious health problem and are far more common than most people realize. In some of the larger cities, hundreds of rat bites are reported each year, and certainly there are many cases that are never reported.

Based upon available records, large metropolitan areas of the U.S. experience rat bite at the rate of approximately 10 per 100,000 persons per year. This amounts to 3-4,000 cases annually just in the large cities alone, and the cases unreported from them and from the smaller cities and towns undoubtedly total several thousand more.

Helpless infants and defenseless adults (invalids and unconscious persons) are particularly subject to attack by rats, and occasionally a rat-bite wound causes death. The victim of an attack is usually terrified by the experience, and the mental and emotional scars that remain are often deeper than the physical scars. Rat-bite wounds should be promptly and carefully disinfected to prevent secondary infection, and where necessary the victim should then be referred to a doctor.

Rodent-Borne Diseases

Rats and mice are responsible for spread at least a dozen diseases, either directly, as by contamination of human food with their urine or feces, or indirectly, by way of rodent fleas and mites. Following are brief descriptions of the more common of these diseases.

1. Rat-Bite Fever

The bacteria that cause rat-bite fevers are found on the teeth and gums of many rats and are transferred from rat to man by the bite of the rat. The most frequently occuring rat-bite fever in the U.S. is called Haverhill fever. It is similar to rat-bite fever in the Orient called sodoku.

2. Leptospirosis (Weil's Disease)

Leptospirosis is a mild to severe infection that is seldom fatal. Human cases of the disease result from direct or indirect contact with infected urine of rodents and of certain other animals. The spirochetes, which are found in water or on food, may enter through mucous membranes or minute cuts or abrasions of the skin.

Thus, Weil's disease is often found among sailors, miners, sewer workers, fish or poultry dealers, and abbatoir workers.

3. Salmonellosis

Salmonellosis, which is generally classed as food poisoning, is a common disease of worldwide distribution. It is an acute gastroenteritis produced by members of the *Salmonella* group of bacteria pathogenic to man and other animals. They are spread in various ways, one being through food contaminated with rat or mouse feces containing *Salmonella* organisms.

4. Trichinosis

Trichinosis results from an infection of the intestines and muscles by larvae and cysts of *Trichinella spiralis*. Man, hogs, and rodents may develop the disease from eating infected pork that is raw or insufficiently cooked. In addition, research has shown that hogs experimentally fed trichina-infected feces of rats and mice readily become infected. This indicates that rodents may play an important role in spreading trichinosis to hogs fed on garbage containing infected rat feces. Such interchange of organisms may significantly help to maintain the rodent-man-swine cycle of this disease.

5. Marine Typhus Fever

This disease is distributed throughout the Southeastern and Gulf Coast states and southern California. Rats are the reservoir animals from which the disease reaches man by way of rat fleas. The oriental rat flea, *Xenopsylla cheopis*, is considered the most important vector of the disease. The causative organism enters the bloodstream when feces of infected fleas are scratched or rubbed into a flea-bite wound or other break in the skin. Murine typhus is similar to epidemic or louse-bourne typhus, but illness is much milder and the fatality rate in untreated cases is much lower.

6. Plague

Plague is the "Black Death" that once killed millions of people in Europe, Asia, and Africa. No serious outbreaks of plague have occurred in the U.S. since 1924. However, a reservoir of the disease exists in wild rodents of the western states, where the bacteria are transmitted from one rodent to another and sometimes to man by the bite of rodent fleas. There is always the danger that domestic rodents will become infected, and that they, in turn, will carry the infection to human population centers. The disease is generally fatal to the rat and the flea, and the death rate in untreated human cases is extremely high.

7. Rickettsialpox

This is a mild nonfatal disease resembling chickenpox. It is transmitted from the house mouse to man by the bite of the house-mouse mite, Liponyssoides sanguineus. In this country, rickettsialpox has been reported from Boston, Mass., West Harford, Conn., New York, N.Y., Cleveland, Ohio, and Philadelphia, Pa.

8. Other Diseases

A number of other diseases of less frequent occurrence are associated with domestic rodents. Among them are toxoplasmosis, listeriosis, and lymphocytic choriomeningitis.

Description and Habits of Domestic Rats and Mice

The term "domestic rodents" includes Norway rats, roof rats, and house mice -- members of the order Rodentia, family Muridae. These rodents are best characterized by having a single pair of incisor teeth on each jaw and by the absence of canine teeth.

Biological Factors

1. Norway Rat

The Norway rat (Rattus norvegicus), predominantly a burrowing rodent, is the most common and the largest of the domestic rats. It is distributed generally throughout the temperate regions of the world, including the U.S. Common names for the species are the brown rat, the house rat, the barn rat, the sewer rat, and the wharf rat.

Adult weight: 16 oz. or more; adults average about a pound.

Fur: Coarse, generally reddish brown to grayish brown, with many variations.

Body: Heavy-set, and with muzzle blunt.

Tail: Bicolored, shorter than body and head combined.

Ears: Small, close-set.

Droppings: Large (1/2-3/4 inch long), capsule-shaped

Sexual maturity: Attained in 2-3 months.

Gestation period: Averages 22 days.

Young: Average 8-12 per litter.

Number weaned: Averages about 20 young per year per female.

Length of life: Averages about 1 year.

Harborage: Outdoors - in burrows in the ground and under foundations of buildings, and in rubbish dumps; indoors - between floors and walls, in enclosed spaces of cabinets, shelving, and appliances, in piles of rubbish, and in any other space concealed from view.

Range: Frequently 100-150 feet.

Food and water: Omnivorous; garbage, meat, fish and cereal baits are well accepted; daily requirement is 3/4 - 1 ounce of dry food and 1/2 - 1 ounce of water.

2. Roof Rat

The roof rat (Rattus rattus) is somewhat smaller than the Norway rat and is a more agile climber. In the U.S. its range is confined largely to the South and to the Pacific coast and Hawaii. Worldwide, it is found most abundantly in the tropical or temperate regions, but is rare or absent in the colder portions of the world.

Adult weight: 8-12 oz.
Fur: Three color phases in the U.S.: the black rat (Rattus rattus rattus), black to slate-gray colored; the Alexandrine rat (Rattus rattus alexandrinus), tawny above and grayish-white below; the fruit rat (Rattus rattus frugivorus), also tawny above, with white to lemon-colored belly. All 3 subspecies have long, prominant guard hairs, and they interbreed.
Body: Slender, muzzle pointed.
Tail: Single color, longer than body and head combined.
Ears: Large, prominent.
Droppings: Medium-sized (1/3-1/2 inch long), spindle-shaped.
Sexual maturity: Attained in 2-3 months.
Gestation period: Averages 22 days.
Young: Average 6-8 per litter.
Number of litters: Averages 4-6 per year.
Number weaned: Averages about 20 young per female.
Length of life: Averages about 1 year.
Harborage: Above ground level; indoors - in attics, between walls, and in enclosed spaces of cabinets and shelving; outdoors - in trees and dense vine growth, and in some California cities, in sewers.
Range: Frequently 100-150 feet.
Food and water: Omnivorous; vegetables, fruits and cereal grains preferred; daily requirement is 1/2-1 oz. of dry food and up to 1 oz. of water.

3. House Mouse

The house mouse (Mus musculus), the smallest of the domestic rodents, is widespread and abundant throughout the U.S. It is found throughout the world from the tropics to the Arctic regions.

Adult weight: 1/2-3/4 ounce
Fur: Dusky-gray
Body: Small, slender.
Tail: Semi-naked, about as long as body and head combined.
Ears: Moderately large, prominant.
Dropings: Small (3/16-1/4 inch long), rod-shaped.
Sexual maturity: Attained in 1½ months.
Gestation period: Averages 19 days.
Young: Averages 5-6 per litter.
Number of litters: As many as 8 per year.
Number weaned: Averages 30-35 young per year per female.
Length of life: About 1 year
Harborage: Nest in any convenient space in walls, cabinets, furniture, or stored goods.
Range: Frequently 10-30 feet.

Food and water: Omnivorous: cereal grains preferred; the mouse is a nibbler; daily requirement is 1/10 ounce of dry feed; it requires little water (3/100 of an ounce per day), often obtained in the foods it eats.

Senses, Ability, and Reactions of Rodents

1. Touch - Well developed in highly sensitive whiskers or vibrissae, and certain guard (tactile) hairs. Rats and mice prefer to run along walls or between things where they can keep their whiskers in contact with side surfaces.

2. Vision - Not too well developed. Apparently they are color blind, so any distictive coloring of poison baits does not reduce their acceptance to rats.

3. Smell - Keen. Rodents apparently like the odors of most foods eaten by man. They are accustomed to the smell of man, so his odor on baits and traps does not repel them.

4. Taste - Not as sensitive as in man. Rats associate sickness caused by poison bait with the bait and not the poison. They prefer fresh food to decayed food.

5. Hearing - A keen sense of hearing. They can locate the source of a noise within 6 inches. Unusual noises cause rodents to attempt escape.

6. Balance - Excellent. A falling rodent always lands on its feet. The roof rat even maintains its balance well while walking on suspended wires.

7. Reaction to Strange Objects - Rats may avoid a new sound or a strange object in their environment for 3 or more days, particularly if their associates are alarmed by it. Other objects are readily accepted by them (examples: food, garbage, etc.) As rodent population pressures build, the rats frequertly exhibit "chain-fright reaction" to disturbances. Mice are more likely to explore new objects and to be caught in newly set traps.

8. Climbing - Roof rats and house mice are good climbers, and the Norway rat can climb quite well when necessary.

9. Jumping and Reaching - Rats can jump nearly 2 feet vertically, 3 feet with a running start; they can jump 4 feet horizontally, and 8 feet from an elevation that is 15 feet above the finish point. Rats can reach upward about 18 inches.

10. Swimming - Rodents are good swimmers. They are able to swim up through floor drains and toilet-bowl traps.

Recognizing Rat and Mouse Signs

Rats and mice are habitually nocturnal and secretive and are rarely seen during the day except when infestations are heavy. Therefore, it is necessary to interpret signs of their activities properly in order to plan control work. These signs are found in secluded places, such as along walls, under piles of rubbish, and behind or under boxes, boards, and thick vegetation. From the rodent signs, one can tell the species present, and whether a rodent infestation is current or old heavy or light.

Droppings

Fresh droppings of feces are usually moist, soft, shiny, and dark, but in a few days they become dry and hard. Old droppings are dull and grayish and crumble when pressed with a stick.

Runways

Rats habitually use the same runways between food, water and harborage. Because of the keenly developed sense of touch in their vibrissae (whiskers) and in specialized hairs along the body, rats prefer continual body contact with at least one vertical surface, such as a fence or wall. Rats also follow "odor trails". Outdoors, their runways are narrow pathways of beaten earth swept clear of debris. Indoors, greasy runways are found along walls, steps, and rafters. Undisturbed cobwebs and dust in a runway indicate that it is not in use.

Rubmarks

Along regularly traveled runways, a dark, greasy mark forms from contact by the rodent's body. Fresh marks are soft and will smear if rubbed. As the grease ages, it dries and gathers dust and will flake off when scratched with a fingernail. The rubmarks of the Norway rat are most commonly found along runways near ground or floor level, while those made by the roof rat are most commonly seen overhead as swing marks beneath beams or rafters at the point where they connect to the walls. Mice do not leave detectable rubmarks except when the infestation is heavy.

Burrows

The Norway rat prefers burrows for nesting and harborage; the roof rat burrows only occasionally. Burrows are found in earth banks, along walls, under rubbish or concrete slabs, and in similar places. If a burrow is in use, its entrance will be free of cobwebs and dust. Fresh rubmarks on harpacked soil at the opeing indicate a well established and presently used burrow. The presence of fresh fragments of food or freshly dug earth at the burrow also indicates current use by rats.

Gnawings

The incisor teeth of rats grow 4-5 inches a year, so these rodents must do some gnawing each day in order to keep their teeth short enough to use. Rats also gnaw to gain entrance and to obtain food. When gnawings in wood are fresh, they are light-colored and show distinct teeth marks. Small chips of wood or other materials indicate recent gnawing. With age, wood gnawings become dark and smooth from weathering and from frequent contact with rodent's body.

Tracks

Fresh tracks are sharp and distinct, whereas old tracks are covered with dust and are, therefore, less distinct. The tracks of the 5-toed rear paws are more commonly observed than are the 4-toed front paws, but both may be present, Smooth tracking patches of any dust material, such as flour or talc, placed along runways, are of value in checking for rodent activity. To see tracks in the dust, the inspector should hold a flashlight at an angle that causes the tracks to cast distinct shadows. Tail marks, too, are often visible in dust or tracking patches.

Control of Rodent Populations

Basic Principles

Controlling rat populations, not individual rats, is the key to a successful rodent-control program in a community. Examples of populations are the rats within a city block, those in a sewer, the rats infesting a farm, or those living in or around a feed mill. At any given time, each city block has a certain capacity to support rats. This capacity is related to the availability of food, harborage, living space, and other vital rodent requirements. The rat population in a block cannot long be greater than this capacity. Permanent reduction of one or more vital factors in the block, particularly food, will result in a permanent reduction in the rodent population.

1. Population forces

Forces that determine the size of a rodent population at a given time are: reproduction; mortality; and movements into or out of an area. Reproduction tends to increase a population, mortality to decrease it, and movements can work either way. Rats breed during the entire year with peaks in spring and fall. Winter is the best time to conduct a poisoning campaign on a rat population, since breeding is then at a minimum. The next best times are summer, then fall. In field tests populations poisoned in the winter took 12 months to return to normal; those poisoned in summer, took only 6 months.

2. Population changes

As rat and mouse populations increase in size, the mortality rate also increases until a state of equilibrium is reached. Increased competition due to population pressure increases the mortality and movements of rodents. Movements into or out of an area are less important in determining the size of rat populations than either reproductioner mortality. Rodents often migrace much greater distance than the limits of their normal home range (rats 100-150 feet, mice 10-30 feet) as, for example, their annual movement from fields to buildings in the fall and then back to the fields in the spring; and their migrations when their usual sources of food are cut off, or when they are flooded or burned out.

Limiting Factors

The factors that control the balance between reproduction, mortality, and movement of rodents are: the physical environment; predation and parasitism; and competition.

The physical environment is composed of 3 main elements: (1) food and water; (2) harborage; and (3) climate. Improperly handled foods, garbage, and field crops often are major sources of rodent food. Climate directly affects the number of rodents able to survive outdoors, but has little or no effect on those living in heated buildings. A given environment can support only a certain number of animals. Generally speaking, areas with warm, moist climates are favorable, while those with dry, cold climates are unfavorable. Man can reduce rodent population and keep them low by permanently eliminating their food, water and harborage. Competition, whether between members of the same species or between two or more species, is one of the most important factors limiting rat populations. Norway rats compete intensely with roof rats and have replaced them over large areas, particularly in many cities where both once were found. Competition among members of the same species is very closely associated with the social organization of a population. A definite social order, or hierarchy, exists among rats and mice. This social order is determined largely by fighting, and the most aggressive animals in a population are dominant. Others are killed or are forced to move. Those that move may suffer even higher mortality from predators and resident rodents in the new areas. The strife caused by increased population pressure lowers reproduction, increases mortality, and decreases the population.

The effect of predators and parasites on reduction of rodent populations appears to be temporary. This includes the predatory activities of man, dog, cats, foxes, rats, birds, snakes and other foes, and the parasitic activities of bacteria, rickettsia, spirochetes, protozoa, and worms.

In summary, the most lasting control can be achieved by increasing competition and predation through permanent alterations of the physical environment. In other words, environmental sanitation is the first and foremost requirement for rodent control.

Sanitation for Rat and Mouse Control

Improper storage of refuse (garbage and rubbish) and of food in the home and in business establishments invites rats to infest blocks and neighborhoods. Rat and mouse populations are controlled by the use of garbage grinders or the storage of all refuse in rodent-proof containers, the satisfactory collection and disposal of refuse, and the proper storage of usable materials. Structural harborage, such as small protected enclosures under cabinets, shelves, and stairs, should be eliminated. Permanent removal of harborage and sources of food will eliminate existing rat and mouse population.

Rodent Killing

Relation to Other Control Procedures

In the community rodent-control program, rodent killing is an important adjunct to improvements in sanitation and other environmental factors. However, timing is of great importance; and control through killing alone does not endure. For these reasons, killing methods can be applied most effectively:

Before sanitation or cleanup programs are begun - to prevent mass movement and spread of rodents.

After dusting with 10% DDT or other insecticide recommended for flea control - to reduce rodent populations, which are the reservoirs of plague and murine typhus.

During and after, or together with, ratproofing work - to eradicate rodents in buildings.

Early in community programs - to stimulate public interest in rodent.

Rat killing without environmental improvements, particularly good sanitation, is ineffective because:

1. Rats and mice rapidly regain the original population level through their high birth rate and the greater survival of young as a result of less competition.
2. A continuous killing program is necessary, which is costly in terms of labor and materials.
3. Continued use of most poisons can result in bait shyness.

Poisons and Baits

1. Poisons and their Modes of Action

The anticoagulants, red squill, and zinc phosphide are the rodenticides generally recommended for use by health departments and by the public. These rodenticides are available commercially and are the ones with which the untrained individual is least likely to experience difficulties.

The anticoagulant rodenticides--such as warfarin, Pival, Fumarin, and diphacinone -- kill in a radically different manner from the older acute (single dose) poisons. They must be ingested for several consecutive days before they become effective. This provides a definite safety factor for a child or an animal that may eat a single large portion of anticoagulant bait. The anticoagulant poisons cause internal hemorrhages, so the poisoned rodents literally "bleed to death". Even when weakened, the rats apparently do not associate their condition with the food supply and will return again and again to feed on anticoagulant-treated baits. So, the problem of bait shyness commonly associated with "one shot" poisons is largely overcome. Non-fatal doses of acute poisons are often painful, whereas anticoagulants apparently cause no pain.

The individual compounds used in rodent control are listed following the text of this study guide. The common name, chemical name, nature of compound, general usuage, toxicity, persistence and hazards of each rodenticide is included.

2. Preparation of Baits

Suggested materials for baits include: fresh, frozen, or canned meats, fish or pet food; bacon, yellow corn meal, cracked corn, hulled oats, rolled oats, canary seed (for mice), apple, sweet potato, melon, tomato, peanut butter, nutmeats, and butter.

Fresh palatable baits are the most acceptable to rats and mice, so mix only enough bait for current needs.

A binder of molasses or of vegetable, mineral, or fish oil is often used in cereal or dry baits to hold the poison and the dry bait together and to aid in mixing.

An emetic, usually tartar emetic, is mixed with zinc phosphide and other more toxic bait formulations to protect animals other than rodents, even though acceptability of such baits to the rodents is thereby reduced. Rats are among the few animals that are unable to vomit.

Mix bait as directed. Too much poison may give the bait a strong taste or odor. Too little will not kill, but may result in "bait shyness". Excessive amounts of poison increase the danger to man and to domestic animals.

Mix baits well. Poor mixing results in non-uniform baits and poor kills, and speeds development of bait shyness. Mechanical bait-mixing equipment is necessary where large quantities of bait are mixed routinely.

CAUTION: Clearly label poisons and mixing equipment. Do not use baitmixing equipment for other purposes. Lock up poisons and mixing equipment when not in use.

3. Bait Placement

A. Anticoagulant baits - are not "one shot" poisons, so they require a different method of use from other rodenticides. Bait mixtures are frequently placed in paper, metal, or plastic pie plates or in permanent bait stations in secluded areas. The number of pie plates or bait stations would vary with the infestation. Small pie plates will hold ¼ to ½ pound, whereas permanent bait stations often hold over a pound of bait mixture. Be liberal in baiting. Anticoagulant bait mixtures will usually be exposed for a minimum of 2 weeks; but where reinfestation is likely, a few bait stations may be maintained on a permanent basis. For anticoagulants to be fully effective, repeated doses must be consumed by every rodent at a given location for a period of 5 or more consecutive days.

Therefore, observe the following instructions:

1. Protect animals other than domestic rodents, and shield baits from the weather under shelter or with bait boxes, boards, pipes or cans.
2. Note locations of all bait containers so that inspections can be made rapidly and the bait that has been consumed can be quickly replaced. (Note: Bait consumption is generally heavy right after initial placement, making daily inspection and replacement advisable for the first 3 days after regular feeding begins.)
3. At each inspection, smooth the surface of the baits so that new signs of feeding will show readily.
4. Replace moldy, wet, caked, or insect-infested baits with fresh ones.
5. If a bait remains undisturbed for several successive inspections, move it to an area showing fresh rodent signs

Anticoagulants can be obtained in three forms: a concentrate to be mixed with baits, a pre-mix ready to be distributed, or in water-soluble form.

Water - soluble anticoagulants are valuable to use with dry baits. They are especially effective where water is scarce, particularly during hot weather. Adding a small amount of sugar makes them more tasty, especially to mice. Stations can be made by putting the water into founts like those used to water chickens.

B. Poisoned Water - When poisoned water is used, place it only where other animals cannot get to it. Use containers that will not spill, such as glass caster cups or low metal or water-resistant paper cups. Chicken founts are satisfactory for permanent stations. Note: Water baits are most effective where other sources of water are limited or can be eliminated, as in feed mills or granaries. British workers report that the use of anticoagulant dust concentrate placed in a patch around anticoagulant poison water stations is effective in mouse control. Milk is an excellant liquid to mix with water-soluable anticoagulants.

C. Single-Dose Poisons - Wrap "oneshot" poison food baits in 4" x 4" paper squares to form "torpedoes" about the size of a large olive. One pound of bait will make about 80-90 such topedoes. These may be tossed readily into otherwise inaccessible places. Rats prefer to carry their food to their harborage to eat it in safety. If several types of bait, such as meat, fish or cereal, are to be distributed at the same time, a different color of paper should be used for each of the various types of bait.

Be generous with baits. Remember, rodents have a limited "home range", usually less than 150 feet for rats and 30 feet for mice. Two few baits, or poorly placed baits, may miss many rodents. Bait liberally where signs of rat activity are numerous and recent. In light or moderate infestations, torpedoes containing a single dose poison, such as red squill, have given good control when applied at a minimum rate of 20 baits per private residence and 40 per small business establishment. As many as 100-200 baits may be required for premises with heavy rodent infestations. Place baits in hidden sites out of reach of children and pets. Inspect and rebate as needed, using another poison and another bait material when the rats become shy of the original baits.

"Throw Bags", which are bags of paper, moisture-resistant paper, or plastic, each containing about ½ pound of anticoagulant or single-dose poison bait mixture, can be thrown into heavily infested sewers and into burrows and other inaccessible places. Some operators pierce the bags in place to make the contents more accessible to rats. However, this makes it more difficult to determine the amount of bait consumed.

D. Prebaiting - When single-dose poisons are to be used, prebating for several nights with 3 or more kinds of unpoisoned baits can increase subsequent acceptance of the poison bait, particularly when rats evidence bait shyness. However, it is too costly a practice for large-scale use. As with poisoned baits, a distinguishing color of paper wrapper should be used for each type of unpoisoned bait material. Prebaiting with distinctively-colored torpedoes of 3 kinds of bait-- for example: meat, fish and grain -- will show the preferred bait material and, at the same time, indicate how man baits are needed and where.

E. Poisoning at dumps - Open dumps, with their continuously replenished supply of food and harborage suitable for rodents, comprise a special problem in the rodent-control program. Until sanitary disposal of refuse is instituted, poisoning may be the only effective means of controlling rats at these sites.

Fifty to 100 pounds or more of poisoned bait may be required to bait a single heavily infested dump. Good results have been obtained by using the following techniques:

(1) Wait about a day after the last load of refuse is deposited at the dump. Provide drinking water if none is available.

(2) Using a single-dose poison, bait heavily for several nights. If rodent ectoparasites or cockroaches are a problem, powder dust with a recommended insecticide.

(3) On the day following the last night of single-dose poisoning, establish a number of anticoagulant rodenticide bait stations and service them regularly until all signs of rat feeding cease.

(4) Level the dump and cover with earth to a depth of 2 feet after compaction.

F. Poisoning in sewers - In sewer systems, as at open dumps, rodents find safe harborage and a constantly replenished supply of food; and, like the open dump, an infested sewer serves as a continuous source of reinfestation for nearby neighborhoods. Unless and until permanent control of sewer rodents is undertaken, by major renovation of old sewers or construction of new, a poisoning program is the only effective means of control. But results of poisoning are short-lived, and sewers must be re-treated periodically. Field trials suggest that 2-4 treatments per year against rats in sewers give satisfactory control.

The most satisfactory effective formulation for use in humid sewers is the paraffin-poison bait mixture, using either an antiocoagulant rodenticide or zinc phosphide as a single-dose poison. An especially provided wire, when attached to the ladder or other suitable point near the top of the manhole, prevents the bait block or bait container from lodging in the sewer and simplifies inspection of the bait station. Paraffin baits to be placed in sewers subject to overflow may be nailed or otherwise fastened to boards of sufficient size to float the can or carton of bait.

Caution: Sewer manholes can serve as reservoirs of poisonous gases and carbon dioxide. A worker should never enter a manhole unless he has a rope tied as a lifeline around his body and helpers present to lift him to the surface -- immediately, if necessary.

4. Trapping

Traps are useful when poisons fail or their use is too risky, where the odor of unrecovered dead rodents would be a problem, and when live-trapped rodents are desired in order to collect rodent ectoparasites and bloods for use in disease studies. For the latter purpose, steel traps and cage-type traps should be used.

The snap trap is one of the most effective devices for killing rats and mice, particularly mice. An attractive bait should be fastened securely to the trigger. For rat control, the trigger should be expanded with cardboard or screen wire and used unbaited. Steel traps (Oneida-Victor size #0 or equivalent) are effective for catching rats alive. Set the trap with the jaws open across the runway and fasten the chain securely. Cage or box traps are usually less convenient and are not as efficient as steel traps, but they catch the rodent uninjured. Placing cage traps in dark places or covering them with material, such as burlap bags, will increase catches. A "choker" -type trap, properly set, may catch several mice per night.

Boiling traps after use to remove human odor is not necessary. Rats live so close to man that his odor is part of their everday experience.

Traps may be baited with oatmeal, peanut butter, raisins, apples, meat scraps, or bacon.

5. Gassing

Gassing of burrows is used as a supplementary measure for killing rodents. It should not be attempted by untrained operators. Several materials are available for this purpose, one being calcium cyanide and another is methyl bromide. Cyanide dust is effective when it can be blown into a burrow system where rodents are concentrated. However, calcium cyanide dust is not effective when the ground is extremely dry. Some moisture is needed in either the soil or the air to convert the dust to gas. Methyl bromide is a grain fumigant which is heavier than air and will follow the holes underground wherever they lead.

CAUTION: Cyanide fumes are highly toxic and rapidly fatal. Avoid inhaling dust or fumes. Cyanide gas is lighter than air. Therefore, burrows that may lead under occupied buildings must not be gassed. Indoor fumigation with this gas must be done only by thoroughly trained professional fumigators.

6. Other Killing Methods

Carbon monoxide gas from an automobile motor left running may sometimes be used for gassing rodent burrows. The fumes from the motor are piped through a hose running from the auto's exhaust pipe into the burrow system. All burrow entrances other than the one to be used for introducing the gas should be searched out and tightly sealed in advance of the operation, thus preventing the escape of the rodents and avoiding dilution of the gas.

This technique is extremely hazardous, however, since the fumes may be forced back through the exhaust system, and any leak in the system could let the deadly gas enter the auto and overcome the occupants. To safeguard against this danger, all car doors and windows must be left open while the motor is running.

Flooding burrows may be a productive technique and is applicable where there are tight clay soils. Water under pressure, as from a garden hose, can be used to drown rodents in their burrow or to drive them out where they can be clubbed to death.

Ratproofing

Ratproofing or vent stoppage consists of changing structural details to prevent entry of rodents into buildings. Openings as small as a half inch will admit young rats. Where only Norway rats are encountered, such openings as ground floor windows, sidewalk gratings, basement vents, utility pipe openings, and foundation walls are normally ratproofed; but, where roof rats are found, ratproofing must also include wires, vertical pipes, and openings to upper floors and roofs. Where only Norway rats are encountered, the stoppage work, in order to be economically feasible, is confined to the most likely points of entry and not to every possible entrance.

Devices

(1) The cuff and channel for wooden doors to side and back entrances prevent rats from gnawing under or around the doors. The front doors of most establishments are less exposed to rats and are generally protected with a kick plats. Wooden door jambs can be flashed with sheet metal to protect them from rat gnawing. Because open doors provide ready entry for rodents, both screen doors and wooden doors to food-handling establishments should be equipped with reliable self-closing devices.

(2) Vents and windows can be made secure against rat entry by screening them with heavy wire mesh, preferably in a sheet-metal frame. If desired, fly screening can be incorporated into the frame also. Wooden surfaces exposed to gnawing must be covered by the frame.

(3) Metal guards of suitable construction should be placed around or over wires and pipes to prevent rats from gaining entrance into a building.

(4) Openings around pipes or conduits should either be covered with sheet metal patches or filled with concrete or brick and mortar.

(5) The use of concrete for basement floors and for foundations not only prevents rat entry, but also increases the value of the property.

(6) Floor drains, transoms, letter drops, and fan openings must receive stoppage consideration.

Materials

(1) 17-gauge, 2" x 2" (½" mesh) galvanized hardware cloth for screening against rats; 19-gauge, 4" x 4" (¼" mesh) for mice.

(2) 18-gauge galvanized expanded metal for screening where exposure to damage is greater than normal.

(3) 24- to 26- gauge galvanized sheet metal.

(4) 1/8-inch brass or aluminum for kick plats.

(5) Concrete, brick and mortar, glass, tile, and other building materials.

Other Considerations

As an adjunct to vent stoppage, buildings should be planned or modified to avoid dead spaces such as double walls, double floors, and enclosed areas under stairways.

Rubbish piles or other materials stacked against buildings should be removed. They provide the means by which rats and mice can bypass otherwise effective stoppage measures.

After buildings have been completely ratproofed, measures should be taken to eradicate the rodents that have been trapped withing.

Inspections should be made at regular intervals to make sure that rats have not been reintroduced in incoming shipments and that the ratproofing work remains intact.

As a general guide in planning prevention measures, it will be assumed that rats can do the following:

1. Gain entrance through openings larger than ½" square.
2. Climb both horizontal and vertical wires.
3. Climb the inside of vertical pipes 1½-4" in diameter.
4. Climb the outside of vertical pipes and conduits with diameters up to 3".
5. Climb the outside of vertical pipes and conduits of any size if within 3" of the wall.
6. Crawl horizontally on any type of pipe or conduit.
7. Jump vertically as much as 36" from a flat surface.
8. Jump horizontally 48" if on a flat surface.
9. Jump horizontally at least 8" from an elevation 15' above the finish.
10. Reach about 18" horizontally or vertically.
11. Drop 50' without being killed.

New Construction

All new buildings should be so designed that they are ratproof. Building codes of communities should be revised, if necessary, to require that new construction be ratproof. Codes should also specify that modifications and repairs be made to existing buildings to render them ratproof.

CHAPTER VI

GRAIN INVENTORY CONTROL

CHAPTER OBJECTIVES

After completion of this chapter the student should be able to:

1. Identify and prevent major losses of grain inventory such as spoilage, mixing, spills, shrink and dust.
2. Develop an understanding of such terms as dormacy, respiration, moisture transfer and the parts of the kernel.
3. Recognize problems and problem indicators of grain such as moisture, temperature, time and odors.
4. Manage grain storage space in either a local elevator or home farm storage system by learning the use of bin charts, consolidation, segregation, temporary storage and inventory measurement.

TEACHING AIDS

1. Grain samples showing each kind of damage.
2. Pans and sieves for demonstrations and lab work.
3. Industry literature showing heat sensing, moisture sensing, protein testing equipment and chemical preservative applicators.
4. Example(s) of bin charts and federal warehouse measurements.
5. Slide sets from Far-Mar-Co. on temporary storage and grain quality.
6. Wall charts or models of grain kernels showing parts of seed.

SUPPLEMENTAL REGERENCES

1. "Aeration of Farm Storage Grains," Extension Engineering in Kansas, E-26.
2. "Sick Wheat", bulletin Kansas State University, C-321.
3. Extension bulletin - "Selling High Moisture Grain in Kansas".

STUDENT STUDY GUIDE

The following terms and questions should be answered from either the enclosed Technical and Instructional Material or Supplemental References.

Grain Shrink -

Dock -

Dockage -

Foreign Material -

Respiration -

"Sick Wheat" -

"Hot Spot" -

Respiration -

Embryo -

Monocotyledons -

Dicotyledons -

Bin charts -

Fines -

Segregation -

Test weight -

STUDY QUESTIONS

1. List the physical causes of shrink.

2. List the economic problems of shrink.

3. When drying high moisture grain one removes ____________________ and ____________________.

4. Calculate all problems.

5. Differentiate between dock and dockage.

6. A seed is a __________ ______________.

7. List the eight parts of a diocot kernel and give the function of each.

   a. - function
   b. - function
   c. - function
   d. - function
   e. - function
   f. - function
   g. - function
   h. - function

8. List the eight parts of a monocot kernel and give the function of each.

   a. - function
   b. - function
   c. - function
   d. - function
   e. - function
   f. - function
   g. - function
   h. - function

9. ________________, ____________________, ______________________ are grains that can easily be blended for storage.

10. ______________, ________________, and ________________ are grains that are not recommended to be blended for storage.

11. Give the critical moisture level for the following grains.

Wheat ________
Soybeans ______
Corn __________

12. Relative humidities above __% affect the respiration rate of seeds.

13. Growing molds are vigorous producers of ________________ and ____________________.

14. Grain looses ___% to ___% dry matter for each 1% moisture reduction.

15. ______________ content of grain is the primary factor controlling its rate of respiration.

16. Death of the germ seedling occurs at ____°F.

17. Molds can produce temperatures up to ____°F.

18. Explain the statement - "Even dry grain can go out of condition."

19. Grain in good condition should be a ____________ ______________ odor, while grain with problems will smell ___________ or __________.

20. Problem: A farmer harvest corn at 25% moisture and its temperature in the bin is 60° F. How many days of storable life does
_______ he have?
At the end of 3 days he dries it to 15% and lowers the temp
_______ to 45° F, how many days does he have left to store the corn?

21. List 2 causes of "hot spots."

1.

2.

22. List the 5 major causes of problems in stored grain.

23. Name 2 physical facts that affect handling of grain in storage?

24. Name 5 things that should be considered before storing grain on the ground.

25. A cubic foot of usable space will hold ____ bushel of standard test grain.

26. The bin chart in the elevator will show the design of each bin; its ____________, ________________, and ____________________ per ft. of height based on standard bushel.

27. Adjustments have been made by the warehouse licensing office for __________________ bin ______________________ and __________________ spout ____________________.

28. Grain falling into a bin will ____________ from the point of ____________ to the outside wall of the bin. This causes ______________ of the grain, for which ______________ must be made.

29. ______________ rates are based on standard grain qualities. Rate adjustment must be made for ____________, ____________, ____________, and __________________ of ____________ in relation to wall area.

30. Measurements must be made from ______________ ______________ of roof slab down to ______________ ________________ of ________________ in bin.

31. ____________ this measurement from the bin's ________________ ________________ as shown on the __________ ____________. This will give the height of ________________ in the bin.

32. Multiply height of grain in the bin times _________ per _________ as shown on the __________ chart.

33. Make adjustments according to its ____________ ____________, ______________, ______________, and __________________.

TECHNICAL AND INSTRUCTIONAL MATERIAL

Grain Shrink

According to Webster shrink means to shrivel, to become smaller or decrease in value. These are all things that can happen to grain inventories if they are not guarded against. There are many things that can cause "shrink" whether the grain is in farm storage, commercial elevators, terminal storage or in transit. The causes of "shrink" will be listed and then discussed at length.

SHRINK

Physical	Economic
1. Moisture	1. Excessive Drying
2. Dockage	2. Lowering of Grade
3. Foreign Material	3. Spoilage
4. Spoilage	4. Mixing of Grain
5. Abrasion	5. Loss in Transit
6. Mixed Grain	6. Theft/Pilferage
7. Insect Damage	7. Scale Weights
	8. Insect Damage

Moisture

Moisture is one of the first items that is removed from the grain when it is weighed across the scales at the elevators. It is also one of the primary factors that affects the storability of that grain. (Storability will be discussed later in the chapter.) Grains differ in the tolerable moisture content that is accepted by most elevators. On the average the following is the maximum amount of moisture that is accepted on most grains before a shrink is taken.

Wheat -- 13.5
Oats -- 13.5
Milo -- 14.0
Corn -- 15.5
Soybeans -- 14.0

Grain kernels shrink in size as they dry because the weight of the additional water in grain is removed. For example, if one hundred pounds of milo has a moisture content of 16%, the grain contains 84 pounds of dry matter and 16 pounts of water. Test weight actually increases as moisture is removed until around 15% then test weight decreases.

Apply this to a farmer trying to sell 300 bushels of wheat containing 16% moisture to the local elevator. It is hard for him to believe that there is over a 55 gallons of excess water. There is actually 56.25 gallons of water in the load of wheat in excess of the 14.0% moisture content that is allowed.

When shrinking grain, it is important to remember that the percentage of shrinkage always exceeds the percentage points of moisture removed. For example, when milo is dryed from 22% down to 16%, 6 percentage points of moisture have been removed. But the original weight of the wet grain must be shrunk by 7.65%. Refer to the Grain Shrinkage Table I and find this.

In addition to the moisture shrink, another factor to consider when buying or selling high moisture grain is the dry matter loss. The loss of dry matter is actually the loss of CO_2 from the grain, and it may vary from ½% to 1% depending on grain quality. It is also represented in the losses from the removal of chaff, broken kernels, and dust when drying grain.

Moisture and dry matter losses may be calculated by using the following formula:

$$100\% - \frac{\%\text{ dry matter in wet grain}}{\%\text{ dry matter in dry grain}} \times 100 \quad + .5\%\text{ dry matter loss}$$

The Grain Shrinkage Table I shows this already calculated for all grains.

In addition to the shrinking the grain in weight, there is cost associated with drying the grain. Drying costs vary but a figure which is commonly used is 1¢ per percentage point of moisture removed.

When buying or selling high moisture grain, to calculate a fair price, use the Grain Shrinkage Table I or the above formula. Shrink the grain to a dry weight moisture which is equivalent to the moisture used by the local markets, and subtract a drying charge when quoting grain prices.

Work the following problems relating to moisture and dry matter shrinkage of grain.

SHOW ALL WORK - Put Answer on the Left.

Problem #1

Gross	23500	Corn	-- 18% Moisture
Tare	8500	Corn Price	-- $2.40 for #2
Net			

________1. How many pounds of water are on the truck in excess of 15.5%?

________2. How many 8-pound gallons of excess water are in the load?

________ 3. Using the Grain Shrinkage Table I, What is the total % shrinkage?

________ 4. What is the average drying cost of this corn?

________ 5. Using the shrinkage figure from Question 3 calculate the number of bushel of #2 corn that this farmer will have to sell?

________ 6. Using the figure from Question 4, what will the elevator pay the farmer for the corn?

Problem #2

Gross	45800
Tare	9900

Milo -- 16.5% Moisture
Milo Price - $3.25/100#

________ 1. How many pounds of water are on the truck in excess of 14%?

________ 2. How many 8-pound gallons of excess water are in the load?

________3. Using the Grain Shrinkage Table I, What is the total % shrinkage?

________4. What is the average drying cost of this milo?

________5. Using the shrinkage figure from Question 3, calculate the number of pounds of milo that this farmer will have to sell?

________6. Using the figure from Question 4 what will the elevator pay the farmer for the milo?

Problem #3

Your farm grain dryer will dry 1000 bushels of corn per hour taking the grain from 20% to 15% moisture.

________1. How many pounds of water per hour does the dryer take out of the grain?

________2. How many gallons of water per hour does the dryer put out into the air?

________3. Using the Grain Shrinkage Table I, what is the total % shrinkage?

________4. Taking the total shrink on the corn, how many bushel of corn is the farmer putting in his storage bin?

Problem #4

You have a 10,000 bushel bin full of milo that is 18.0% mo[illegible] You turn your aeration fans on and run them for 20 days. You now find that the moisture is 15%.

________1. Using the Grain Shrinkage Table I, what is the total % shrinkage?

________2. How many total pounds did you shrink the milo?

________3. At $3.75 per hundred, how many dollars did you remove from the milo bin?

Dockage

According to "The Official United States Standards for Grain" the definition of dockage shall be weed seeds, weed stems, chaff, straw, grain other than the predetermined grain, sand, dirt, and any other

GRAIN SHRINKAGE TABLE I

GRAIN SHRINKAGE TABLE I SHRINKAGE WHEN GRAIN IS DRIED TO THESE LEVELS ⟶

Initial Moisture	12.0%	12.5%	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%	17.5%	13.0%	18.5%	19.0%
Percent						(Percentage of shrinkage)									
15.5	4.48	3.93	3.37	2.81	2.24	1.67	1.09	-	-	-	-	-	-	-	-
16.0	5.05	4.50	3.95	3.39	2.83	2.25	1.68	1.09	-	-	-	-	-	-	-
16.5	5.61	5.07	4.52	3.97	3.41	2.84	2.26	1.68	1.10	-	-	-	-	-	-
17.0	6.18	5.64	5.10	4.55	3.99	3.42	2.85	2.28	1.70	1.10	-	-	-	-	-
17.5	6.75	6.21	5.67	5.12	4.57	4.01	3.44	2.87	2.29	1.70	1.11	-	-	-	-
18.0	7.32	6.79	6.25	5.70	5.15	4.59	4.03	3.46	2.88	2.30	1.71	1.11	-	-	-
18.5	7.89	7.36	6.82	6.28	5.73	5.18	4.62	4.05	3.48	2.90	2.31	1.72	1.11	-	-
19.0	8.45	7.93	7.40	6.86	6.31	5.76	5.21	4.64	4.08	3.50	2.91	2.32	1.72	1.12	-
19.5	9.02	8.50	7.97	7.44	6.90	6.35	5.79	5.23	4.67	4.10	3.52	2.93	2.33	1.73	1.12
20.0	9.59	9.07	8.55	8.01	7.48	6.93	6.38	5.83	5.27	4.70	4.12	3.54	2.94	2.35	1.74
20.5	10.16	9.64	9.12	8.59	8.06	7.52	6.97	6.42	5.86	5.30	4.72	4.14	3.55	2.96	2.36
21.0	10.73	10.24	9.70	9.17	8.64	8.10	7.56	7.01	6.46	5.89	5.32	4.75	4.16	3.57	2.97
21.5	11.30	10.79	10.27	9.75	9.22	8.69	8.15	7.60	7.05	6.49	5.93	5.35	4.77	4.19	3.59
22.0	11.86	11.36	10.84	10.33	9.80	9.27	8.74	8.19	7.65	7.09	6.53	5.96	5.38	4.80	4.21
22.5	12.43	11.93	11.42	10.90	10.38	9.86	9.32	8.78	8.24	7.69	7.13	6.57	5.99	5.40	4.83
23.0	13.00	12.50	11.99	11.48	10.97	10.44	9.91	9.38	8.84	8.29	7.73	7.17	6.60	6.03	5.44
23.5	13.57	13.07	12.57	12.06	11.55	11.03	10.50	9.97	9.43	8.89	8.34	7.78	7.21	6.64	6.06
24.0	14.14	13.64	13.14	12.64	12.13	11.61	11.09	10.56	10.03	9.49	8.94	8.38	7.82	7.25	6.68
24.5	14.70	14.21	13.72	13.22	12.71	12.20	11.68	11.15	10.62	10.09	9.54	8.99	8.43	7.87	7.30
25.0	15.28	14.79	14.29	13.79	13.29	12.78	12.26	11.74	11.22	10.68	10.14	9.60	9.04	8.48	7.91
25.5	15.84	15.35	14.87	14.37	13.87	13.37	12.85	12.33	11.81	11.28	10.75	10.20	9.65	9.09	8.53
26.0	16.41	15.93	15.44	14.95	14.45	13.95	13.44	12.93	12.41	11.88	11.35	10.81	10.26	9.71	9.15
26.5	16.98	16.50	16.02	15.53	15.03	14.54	14.03	13.52	13.00	12.48	11.95	11.41	10.87	10.32	9.76
27.0	17.55	17.07	16.60	16.11	15.62	15.12	14.62	14.11	13.60	13.08	12.55	12.02	11.48	10.93	10.38
27.5	18.11	17.64	17.17	16.69	16.20	15.71	15.21	14.71	14.20	13.68	13.16	12.63	12.09	11.55	11.00
28.0	18.68	18.21	17.74	17.26	16.78	16.29	15.79	15.29	14.79	14.27	13.75	13.23	12.70	12.16	11.61
28.5	19.25	18.79	18.32	17.84	17.36	16.87	16.38	15.88	15.38	14.87	14.36	13.83	13.30	12.77	12.23
29.0	19.82	19.36	18.89	18.42	17.94	17.46	16.97	16.48	15.98	15.47	14.96	14.44	13.91	13.38	12.85
29.5	20.39	19.93	19.47	19.00	18.52	18.04	17.56	17.07	16.57	16.07	15.56	15.05	14.52	14.00	13.46
30.0	20.95	20.50	20.04	19.58	19.10	18.63	18.15	17.66	17.17	16.67	16.16	15.65	15.13	14.61	14.08

material other than the predetermined grain, which can be removed readily from the grain by use of appropriate sieves and cleaning devices.

In common language it is anything that can be mechanically removed from the sample of grain. It is sometimes figured at the elevator when the load is weighed across the scales. It is always given to the nearest .5%. It is broken down according to the following:

Actual Dockage	Graded Dockage
.000 - .499	.0
.500 - .999	.5
1.000 -1.499	1.0
1.500 -1.999	1.5
2.000 -2.499	2.0

Now we need to understand dockage and its usage. The term dock is always associated with weight. When we talk about discount we mean a reduction in price or dollars. When we talk about dockage we mean a reduction in net pounds.

Foreign Material

According to "The Official United States Standards for Grain" the definition of foreign material shall be all matter other than the predetermined grain which is not separated from the sample in the proper determination of dockage. In common language it is anything which cannot be mechanically removed from the sample of grain. This material has to be actually hand picked with tweezers from the sample by anyone who grades. It is figured as a % of the whole sample and is used when determining the numerical grade.

Examples of Foreign Material -- In Wheat - rye, cheat, milo, joint grass
Corn - soybeans, cracked corn
Soybean - corn
Milo - wheat, rye

Spoilage

Spoilage is a result of excessive moisture, high temperature or insects in the grain. The grain is generally put into storage with too much moisture or too high temperatures. Moisture may get into the storage facility through seepage or severe blowing storms. For this reason farm stored grain should be checked on frequently. It should be particularly checked after severe rain or snow storms. A spot check weekly is an excellent practice to establish.

The use of thermo couples located periodically throughout commercial and farm storage facilities are a fast and easy way to check for elevated temperatures in grain. Anytime there is a 3-5^0 F. increase in grain temperature over a weeks time there is a problem and it needs immediate attention to prevent an excessive amount of spoilage.

Temperature increases within 60 days of harvest generally is an excessive moisture problem. Temperature increases after that time generally indicates an insect problem. Heating from mold growth can however be a combination of moisture and insects problems.

Insect Damage

Types of insects and their damages have been discussed in great detail in Chapter V. The main thought to point out here is that insects can cause a tremendous amount of shrink on grain if they are not controlled and or prevented.

Abrasive Loss

This is a type of loss that occurs each time grain is turned or handled through the system. Official weight losses in commercial elevators, indicate that there can be as much as .025% loss or shrink in grain each time it is handled or turned.

Dust

Dust are the fines that occur from several different places. It can come from abrasive loss, insect damage, excessive dockage, poor housekeeping, or poor harvesting methods. The most important factor about dust is the hazard that it carries if it is not handled properly. Elevators spend thousands of dollars annually trying to control the amount of dust in the facility. Many lives have been lost due to dust explosions in elevators where dust was not controlled. Some feed companies but dust from elevators and use it as protein or binder in some animal rations. Depending on the harvest conditions and the type of grain handled dust can cause a considerable amount of shrink in grain. (The safety aspect of dust control was discussed in Chapter II).

Transit

Transit shrink is primarily the loss of grain between the farm storage bin, the elevator or its final destination. A record was kept of loss in transit during a three month period and found that $1 million was lost due to leakage of vehicles. If one ever notices the roads leading into elevators, or watch semi-trailer trucks driving down the highway you can spot a sizable loss. Railroad car loading and unloading areas you will see additional losses of grain.

Employee Carelessness

This is a practice that any grain handler can not over stress. It is very easy when handling grain of different types to get them mixed in the pit or bin. In most cases it is very costly to try to separate them and in some cases like rye, wheat or oats mixed they can not be separated. Anyone working with different grains should be very careful not to mix them because a lot of shrink could result.

Pilfrage

The stealing of grain is something that can be prevented if the proper precautions are taken by personnel. All bins and facilities should be securely locked when work is done or at closing time.

Kind of Grain

Some kinds of grains have a tendency to shrink more than others due to the amount of hulls and fines in them. Most grain handlers use .5% shrinkage on wheat, corn and soybeans and 1% on milo. But this to depends on the facility, the condition of the grain as it comes into the facility, how much handling, turning, drying and aeration that takes place while in the elevator.

Scale Adjustment

This is an area that is very closely scrutenized by the department of weights and measures. All elevators and scales are periodically checked by this department.

There is a trend toward the use of electronic scales of all types. They are suppose to be a lot more accurate with conditions staying the same. What I mean by this is the sun shining through the window on the electronic scale can cause a great change in gross or net weight of a truck in a very short time. I have seen this happen several times until the people got wise to what was happening.

Problems of this type should be watched for and definitely prevented.

GRAIN AND SEED PHYSIOLOGY

Dormacy and Respiration

Even though it may exist in a dormant condition, a seed contains living material. The maintenance of this life requires the utilization of the nutrient material of the seed and involves the uptake of oxygen from the air and the release of carbon dioxide, water and heat. This process, which is common to all living organisms, is known as respiration.

Parts of a Kernel

Each seed contains an embryo, which in actuality is a young plant. It consists of two basic sections, the cotyledon and the embryo - axis of the plant (stem and root). The grasses, including corn and wheat have only one cotyledon so this group is called monocotyledons or monocots. Plants such as beans and cotton are dicots. The cotyledons are actually leaves so they may be called seed leaves. The leaves are connected to the embryo axis on the first node. The embryo this is a small plant since it contains roots, stems, and one or more leaves. The cotyledon (seed leaf) in monocots is specialized in location and function and is called the scutellum.

The bean seed shown in Figure I is a true seed. Its outer coat is called the testa. It is one of the dicots that contains no endosperm, but the embryo contains two cotyledons for food storage. The stem portion is called the epicotyl, the root portion is called the radicle (embryonic root that develops into primary root) and the section just below the cotyledon is called the hypocotyle.

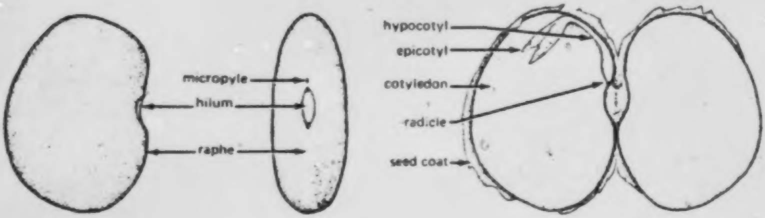


Figure I

The corn kernel, Figure II and wheat kernel, Figure III are caryopsis which is a simple, one-seeded, indehiscent (nonsplitting) fruit with a pericarp firmly united around the seed coat. The pericarp serves as a protective tissue for the internal parts of the caryopsis and is composed primarily of ovary tissue. This ovary tissue will have the same characteristics as the mother plant. Corn and wheat are monocots, thus the embryo contains one cotyledon, known as the scutellum, a coleoptile, the short stem with small leaves, a radicle, and a coleorhiza. The primary function of the scutellum is the secretion of enzymes which help break down the carbohydrates in the endosperm to provide energy for use by the germinating seed and eventually for the seedling. The coleoptile is the uppermost part of the embryo axis and functions as a protection sheath for the terminal bud and young leaves. The coleoptile consists of hard tissue and is pointed. Thus, it is an adapted structure for penetrating through the soil surface. On the opposite end of the embryo axis is the radicle which is the first part of the embryo to emerge from the kernel during germination and which develops into the primary root. The coleorhiza is a protective sheath which surrounds the radicle. During germination the coleorhiza expands in size as water is imbibed. This gives the appearance of the coleorhiza emerging as the pericarp is broken. The radicle emerges through the coleorhiza during germination, and the coleorhiza provides a seal on the primary root so disease organisms cannot enter through areas where the root broke out of the caryopsis.

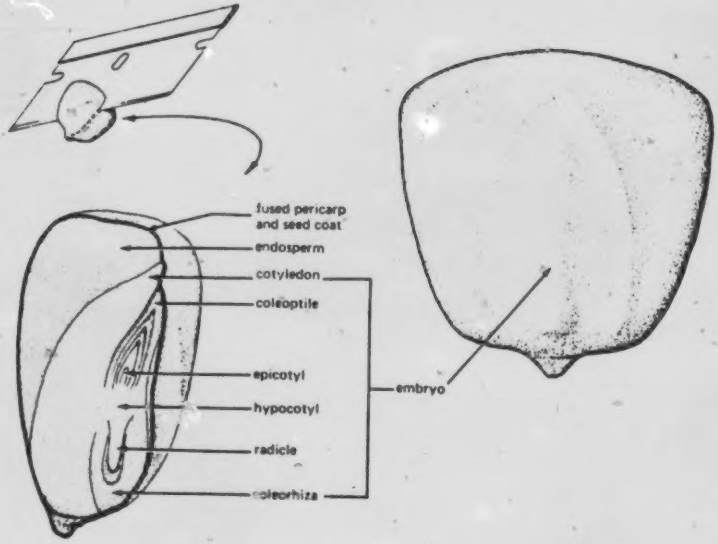

fused pericarp and seed coat
endosperm
cotyledon
coleoptile
epicotyl
hypocotyl
radicle
coleorhiza
embryo

Figure II

Moisture Transfer

Some seed kernels have the ability to transfer between kernels and some do not. There are also a few - Don't which should be remembered before blending grain. The first thing to consider is the blending being done for storage or for shipment.

For storage one should not blend wet corn, soybeans or milo because they do not have the ability to transfer moisture from one kernel to the other because of the seed coat.

The seed coat is influential to its character and cycle. The bran coat on wheat will give up and, or absorb moisture at any time throughout its entire circumferance. In contrast corn has a waxy pericarp. Hence a kernel of corn or soybeans and milo only absorbs or gives

Kernel of Wheat

The kernel of wheat is a storehouse of nutrients needed and used by man since the dawn of civilization.

This cross section shows the nutrients in each part of the kernel. They are considered essential in the human diet.

ENDOSPERM . . . about 83% of the kernel

Source of white flour. Of the nutrients in the whole kernel the endosperm contains about:

70-75% of the protein
43% of the pantothenic acid
32% of the riboflavin
12% of the niacin
6% of the pyridoxine
3% of the thiamine

(B-complex vitamins)

Enriched flour products contain added quantities of riboflavin, niacin and thiamine, plus iron, in amounts equal to or exceeding whole wheat — according to a formula established on the basis of popular need of these nutrients.

BRAN . . . about 14½% of the kernel

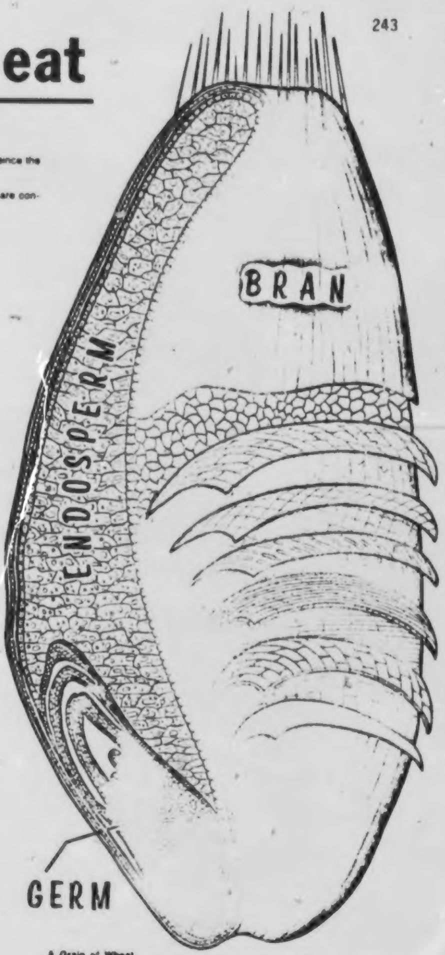
Included in whole wheat flour.
Of the nutrients in whole wheat, the bran, in addition to indigestible cellulose material contains about:

86% of the niacin
73% of the pyridoxine
50% of the pantothenic acid
42% of the riboflavin
33% of the thiamine
19% of the protein

GERM . . . about 2½% of the kernel

The embryo or sprouting section of the seed, usually separated because it contains fat which limits the keeping quality of flours. Available separately as human food. Of the nutrients in whole wheat, the germ contains about:

64% of the thiamine
26% of the riboflavin
21% of the pyridoxine
8% of the protein
7% of the pantothenic acid
2% of the niacin



A Grain of Wheat
(enlarged approximately 35 times)

Figure III

up moisture at its point of attachment. This explains why wheat, barley and rye will average moistures, when blended in storage as long as the final blend is not over 14% moisture. Each kind of seed has its own perculiar characteristics. Wheat will "sweat" and germinate within 28 days. Corn and milo normally require +90 days.

One other thing that should be remembered is never blend old crop and new crop grains because their temperatures and moisture levels are at such extremes it won't work. I realize a lot of these practices are done at home and in the elevator but I don't recommend them because they can cause problem in the storing of the grain at a later time.

When blending for shipment one can blend any grain to whatever moisture level you desire, because it is the recipients responsibility to care for the grain and keep it at the grade which he received it.

PROBLEM AND PROBLEM INDICATORS

Moisture

The fundamental causes of grain spoilage and heating in storage have been a subject of investigation for nearly 30 years. During this time, there has been an increasing trend toward the storage and shipment of grain in bulk. Information on the fundamental causes of grain spoilage and heating, and methods for their prevention, are therefore of timely importance.

The water content of grain is a primary factor controlling its respiratory rate, which may go so high that the grain bulk will begin to heat. As moisture content of dry grain is increased, the respiration increases gradually until a certain critical moisture level is reached. Each kind of seed has its own particular danger point. Small moisture increases beyond this point cause some drastic increases in respiration, and heating tendencies appear. It was once supposed that this critical moisture value was an inherent characteristic of the seed itself, but it is now known that his sharp increase in respiration is due to the germination and growth of mold spores which are on and within the seed coats of the grain.

Mold

Research workers have shown that certain molds commonly found in soil, whose spores may be carried about freely in the air, are almost invariably present in normal grain, even through this grain would be grown and harvested under ideal conditions. How and at what stage of growth these molds become established in the seed coats is not known. Their presence there is perfectly harmless as long as the moisture content of the seeds remains below the critical value. However, if the moisture content exceeds the minimum required for their germination, and if other conditions such as temperature and the supply of nutrients are suitable, the mold spores germinate and produce abundent growth.

Growing molds are vigerous producers of carbon dioxide and heat. This causes chemical deterioration of the starches, proteins, and fats, and results in a decrease in grain quality. When moisture and heat cannot readily escape, such as in a large grain bin or a railroad car, the heating effects due to mold respiration may become pronounced, with the result that deterioration proceeds at an uneven, more rapid pace.

The moisture point at which the contaminating molds begin their growth varies with different grains. Thus, the critical moisture level for wheat is about 14%, flaxseed 10.5%, soybeans 14%, and corn about 14%. Whereas, these moisture values may be different in the various species of seed, they are all in equilibrium with approximately the same relative humidity of the air surrounding the seeds, namely, 74 to 75%.

Relative Humidity

At relative humidities above 75%, the respiration of the seed itself becomes a factor in spoilage. At relative humidity below 75% only respiration of seed causes heat, but about 75% molds create more heat and spoilage begins rapidly.

Respiration rates for wheat:
14.3% Moisture - Relative Humidity 74%: Seed 1. : Mold 0
14.6% Moisture - Relative Humidity 75%: Seed 1.25: Mold 5
16.0% Moisture - Relative Humidity 80%: Seed 2.5: Mold 75

Refer to Table II for more comparisons of different grains with absorbed moisture in equilibrium with various relative humidities.

The same kinds of molds are usually present on these different seeds, and it is these molds which begin to grow at the common air humidity level of 75%, or at the critical moisture value of the seed at this humidity. Furthermore, if the grain is frozen, weathered, threshing damaged, shriveled, or immature, the mold spores will germinate and grow at a somewhat lower humidity than they would on sound, mature seed, for the reason that nutrients are much more easily available to the mold on the damaged grain. In such grain, the respiratory and digestive ferments continue to function after death of the seed. Indeed, the activity of these enzymes may be greater than in sound seeds, just so long as the temperatures do not go high enough to injure these enzymes. The activity of these seed ferments supplements the mold spoilage by preparing soluble nutrients from the seed tissues. All of these reasons account for the fact that damaged or poor quality grain tends to heat and go out of condition at a somewhat lower moisture level and at a more rapid rate than does high quality grain.

TABLE II

MOISTURE CONTENTS IN PERCENTS

GRAIN	RELATIVE HUMIDITY @ 77°F						
	15	30	45	60	75	90	100
Corn (YD)	6.4	8.4	10.5	12.9	14.8	19.1	23.8
Sorghum	6.4	8.6	10.5	12.0	15.2	18.8	21.9
Soybeans	---	6.2	7.4	9.7	13.2	---	---
Wheat (HRW)	6.4	8.5	10.5	12.5	14.6	20.1	25.3
Barley	6.0	8.4	10.0	12.1	14.4	19.5	26.8
Oats	5.7	8.0	9.6	11.8	13.8	18.5	24.1

TABLE III

TEMPERATURES F°	MOLDS BACTERIA FUNGI INSECTS
240	Most destroyed in 1/2 to 3 hours
212	Populations reduced in dryers
165	Reproduction Retarded
140	Germ damage
120	Critical natural point
60	Fumigant minimum
40	Reproduction reduced
32	Dormancy
0	

% MOISTURE

1.18 to 1.23 dry matter loss for each 1.% moisture reduction

30%	optimum corn harvest field loss reduction but requires drying.
25	sorghum immature
22	(wheat immature) Feed Grains Optimum Aeration Moisture Migration in Bins
18	Hazards Multiply Rapidly
15 1/2	No. 2 Corn
15	No. 3 Sorghum-Beans-Trouble
14	No. 1 Corn-No. 2 Sorghum & Beans
13	No. 1 Sorghum & Beans-Wheat Tough
12	Most natural Respiration End %
10	No reproduction
8	Grain easily broken

While many species of molds and bacteria have been found in normal grain, only a few of the molds are responsible for the respiratory and heating effect, since only a few can grow at the humidities normally encountered in grain storage. Unfortunately, among these few are certain types which are extremely toxic to the seed, since they may kill the seed in a period of just a few days. If grain is to be used as seed, it is a good idea to apply seed treating compounds that prevent the growth and killing effect of these molds.

Although mold growth is the principle cause of respiration, heating and deterioration of grain at relative humidities above 75%, the respiration of the seed itself is also a factor. At humidities below that critical for mold growth, the respiration of grain is almost entirely due to the seeds. Above this point, the molds are the principle contributors to respiration.

Temperature

It is known that at moisture values where seed germination occurs (35% or more), heating due to germination ends with the death of the seedlings at about 110° F., whereas, molds will produce and tolerate temperatures up to 130° F. If the moisture content of the grain is very high and approaches equilibrium with a relative humidity of 100% in the atmosphere, bacteria may begin to grow. Certain species of these microorganisms can produce temperatures as high as 160° F. Refer to Table III for further effects of temperatures and % moisture on grain.

Grain damage, which may be brought about in a short time by mold growth, may appear at the same moisture values but at a much slower rate when mold growth is absent. Among the types of damage not due to mold growth but to the influence of high moisture on the seed metabolic processes is that known as "sick wheat". This condition, which may arise in damp wheat in bulk storage, is characterized by loss of viability and a darkening of the germ portion of the grain. The baking quality of flour produced from such grain is very poor. This condition appears to be associated under practical conditions with very high inter-seed carbon dioxide concentrations which would suppress the mold growth.

While the storage life of damp grain can be extended considerably by hindering mold growth, the fact that damaging changes will occur in the seeds themselves rules out the storage of damp grain for any length of time. A search is in progess in the Division of Agricultural Biochemistry for chemical treatments which would be useful to hinder mold growth and thus reduce the rate of spoilage of damp grain. The principle value of such mold-inhibitory treatment would be to prevent excessive damage during a period just long enough to allow the grain to be fed on the farm or to protect it on its way to drying facilities. Grain with moisture values below the critical point will store and keep well indefinitely, and drying offers the only adequate solution to the preservation of damp grain.

Normally matured dry grain, or damp grain which has been dried to safe moisture levels, will keep well as long as the low moisture values are maintained. However, it has been shown recently that even such grain may deteriorate because of poor storage conditions. For example, large temperature differences across a bulk of grain, as might occur in a farm bin where one wall faces the sun and the opposite wall is in the direction of cool, prevailing winds, may lead to a migration of moisture vapor from the warm to the cooler areas of the grain. Under such conditions, the humidity of the air between seeds in the cooler portion will rise, while the grain the warmer region will tend to dry out. If the critical humidity value is reached by the atmosphere surrounding the grain in the cool area, mold growth will commence and spoilage and heating will begin. Furthermore, the growth of molds is accompanied by an actual increase in moisture content of the grain, which would tend to speed up the deteriorative process.

In this way, even "dry" grain may eventually go out of condition. Figure IV shows where grain spoilage is likely to occur in the fall or winter. It shows the convection air currents with warm grain in a bin with colder air surrounding it. Figure V shows where grain spoilage is likely to occur in the spring or summer. It shows the convection air currents with cold grain in the bin and warmer air surrounding it.

Strict supervision of storage conditions and frequent examinations of stored grain is therefore essential.

Figure IV

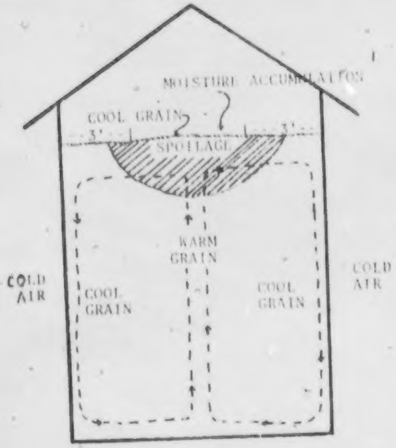
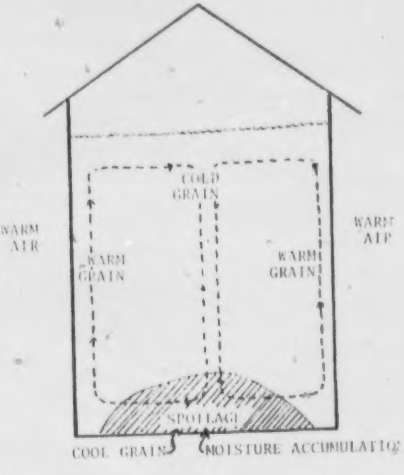

MOISTURE ACCUMULATION
COOL GRAIN
3'
3'
SPOILAGE
WARM GRAIN
COLD AIR
COOL GRAIN
COOL GRAIN
COLD AIR

Figure V


COLD GRAIN
WARM AIR
WARM AIR
WARM GRAIN
WARM GRAIN
SPOILAGE
COOL GRAIN
MOISTURE ACCUMULATION

Odors

Experienced grain men also use other indicators that they have learned through the years. Your sense of smell is valuable as it will indicate trouble. Grain, in good condition, has a sweet clean odor, while grain with a sour or musty odor tells you of problems. Use your nose while working. Smell the grain while you are handling it, smell the tops of each bin, smell all around your elevator while you are working. This may save you lots of work later on.

Time

Tied together with % moisture and temperature that have been previously discussed, time is a very critical factor that affects the quality of the grain.

Table IV gives the maximum time for storage of shelled corn at different moisture levels and temperatures.

TABLE IV

MAXIMUM TIME FOR STORAGE OF SHELLED CORN
(U.S.D.A. Grain Storage Research Laboratory Report)

Storage Air Temperature	Corn Moisture Content			
°F	15% Days	20% Days	25% Days	30% Days
65°	207	21.5	7.8	4.6
60°	259	27	9.6	5.8
55°	337	35	12.5	7.5
50°	466	48	17	10
45°	725	74	27	16
40°	906	94	34	20
35°	1,140	118	42	25

Assuming 30 percent moisture shelled corn at 50° F. is stored for five days, one-half of its allowable storage life is used up. The sixth day, the moisture content of the corn is reduced to 20 percent and held at 50° F. Since one half of the storable life was used up, it now has an allowable storage life remaining of twenty-four days--NOT the forty-eight showing on the chart.

The times given are those which mold growth will cause enough loss in corn quality to bring about a lowering of grade. During the time listed, grain will lose 1/2 percent dry matter, but no lowering of grade.

Corn has a certain allowable storage life. A percentage of this allowable storage life is used up at each moisture content, if its moisture content is reduced in stages.

Two possible alternatives for drying are indicated by the table, which would require no change in drying capacity. Cool high moisture corn to relatively low temperatures and hold for later drying (30 percent of corn cooled to 35^0, holds for twenty-five days.) Or, dry the corn instages, which increases the drying capacity of the drier and allows a significant increase in holding capacity of the corn, until it can be further dried.

Table V and VI show the storage life of barley and wheat respectively.

Hot Spots

Any time there is over a $3\text{-}5^0$ F increase in temperature in a given area of grain in a time period of a few days to a week you have the beginning of what is called a "hot spot." There are two different types of "hot spots."

1. Those caused by high moisture and storage molds. Blue mold penicillium is the primary one but there are several others. It grows in tough or damp spots within the bulk grain. As mold develops, the temperature rises until the heat produced inactivates and kills the mold. Hot spots that contain only molds can be removed and destroyed.

2. Those caused by insects. They develop in moist pockets in dry grain and create their own heat and moisture. Because the insects may spread throughout the grain, satisfactory control cannot be obtained by removing and destroying the "hot spot." This type of "hot spot" has been a problem in shipping grain overseas. If some moisture gets in grain while it is being loaded on the ship or in transit for a long period of time the insect population can be very large by the time the grain reaches its destination. There are three insects that have caused a lot of problems in this area.

    1. The rusty grain beetle can complete its life cycle in 24-98 days at $21\text{-}38^0$ C. The adults can live 6-12 months and they can increase 60 fold in one month.

    2. The sawtooth grain beetle can complete its life cycle in 20-80 days at $18\text{-}38^0$ C. The adult can live 6-10 months and they can increase 50 fold in one month.

TABLE V

Estimated Maximum Duration of Storage in Weeks Before Germination will Begin to Decrease.

Type of Crop	Moisture Content (Wet Basis) in %								
Barley	11.0	12.0	13.0	14.0	15.0	16.0	17.0	19.0	23.0
Storage Temperate	Storage life (weeks)								
25^0 C	54	39	25	16	9	5	2.5	1	-
20^0 C	110	80	50	32	19	10	5.0	2	.5
15^0 C	240	170	100	65	40	20	10	4	1.0
10^0 C	600	400	260	160	90	50	21	8.5	2.0
5^0 C	>1000	1000	6000	400	200	120	50	17	4.0

TABLE VI

Estimated Maximum Duration of Storage in Weeks Before Germination will Begin to Decrease.

Type of Crop	Moisture Content (Wet Basis) in %							
Wheat	12.0	13.0	13.5	14.5	15.5	16.5	17.5	19.5
Storage Temperate								
25° C	31	22	16	11	17	4	2.0	.5
20° C	55	40	28	19	13	7	3.5	1.5
15° C	100	75	50	30	20	12	6.0	3.0
10° C	200	140	95	60	38	20	11	4.5
5° C	370	270	170	110	70	39	20	9.0

3. The grain mite has a life cycle of 20 days at 5-27° C. It can increase 2500 fold in one month.

Most elevators and some farm storage systems have a temperature indicating (hot spot) system installed in their bins. This valuable tool will assist you in preserving the quality of grain in bins. It is important to use it on a regular basis. Your hot spot will make you aware of trouble spots which call for remedial action. The experienced grain handler will take temperature readings daily during and after harvest. After his grain is put away for storage, he will then take regular readings to assure that the grain is keeping well. Any change in condition within the bin will be indicated by a rise in temperature. This may be in one spot or in more than one position in the bin. Any pronounced rise in temperature, calls for immediate action. The problem may be caused by moisture, insects or any of the other indicators that we have discussed and it demands your quick attention.

MANAGEMENT OF SPACE

Bin Charts

Your most important tool in the management of space is your bin chart showing your elevator bins, depth, size, location and their condition. The bin chart should be kept up to date at all times showing the type and quality of grain in the bins, moisture, test weight, date of filling, quality factors if known, insect control, and any other information that may be beneficial. Be sure you have a bin chart in your elevator and then use it at all times as it is very valuable working tool. This chart is used when buying grain so the new grain of similar grades can be put togethe It can be used when selling grain so specific bins of predetermined grades can be sold together or else blended together to meet a specific grade. An example is shown in Table VII.

The importance of working closely with your manager should be stressed. Keep him informed as to the condition of the grain, available space, trouble spots, and actions needed in the elevator. He will depend on you to keep him up to date on your operation, and only with your cooperation, can he make management decisions effectively.

Separation

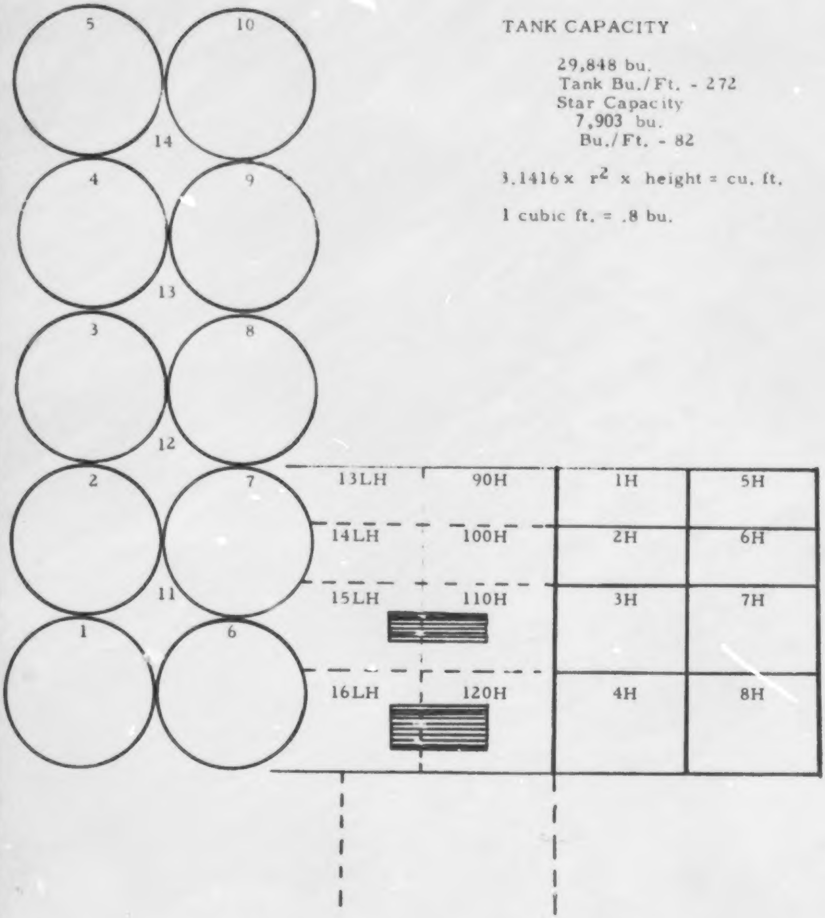
Two important sets of Physical Facts that affect Handling of Grain in Storage are:

1. Separation of particles by size and weight.

2. Moisture migration in grain bins.

TABLE VII

BIN CHART


5
10
14
4
9
13
3
8
12
2
7
11
1
6
13LH
90H
1H
5H
14LH
100H
2H
6H
15LH
110H
3H
7H
16LH
120H
4H
8H

TANK CAPACITY

29,848 bu.
Tank Bu./Ft. - 272
Star Capacity
7,903 bu.
Bu./Ft. - 82

$3.1416 \times r^2 \times$ height = cu. ft.

1 cubic ft. = .8 bu.

1. The heavy "fines" or wet-sticky particles will accumulate in a column below the loading spout. "Fines" are exposed starch, may include immature or wet material as well as weed seeds.

The lighter weight trash - the more mobile dockage will flow to the outside of the cone of grain producing a problem area around the perimeter of the bin.

Both problem areas, by nature of the materials, will inhibit the movement of the atmosphere through the grain mass.

2. Moisture migration in a grain mass is due to the difference in temperatures within the bin. The column of fines tend to generate heat. The outside wall -- or the top may be cold. As the warm air moves up it is displaced by cooler air seeking lower levels.

Warm air can carry more water than can cold. Therefore, moisture will condense in or on the colder areas.

These facts are the reasons why turning, ventilation, or aeration are the tools of the trade to grain handlers.

Segregation

Just as separation - segregation occurs in loading a bin - even more variation may occur in emptying bins.

For example, a center loaded - center draw-out bin will produce the column of heavy fines early in the stream. The bin bottoms, the lighter weight materials, will be produced alternately later in the stream. The alternating bridging and dropping will occur during reduction of grain levels depending and varying as to the relative uniformity of the material. Each bin - and each material - has its own flow characteristics.

There is no substitute for uniformity - clean and dry to maintain quality. This is most efficiently determined by the man managing the production and the man operating the combine. In-house grain cleaners are helpful - but also slow and costly.

Blending from two or three bins at staggered levels when loadout orders are being filled will do much to maintain the top average of potential quality in grades.

Knowing the grades of the inventory and loading to the maximum grade potential is the mark of a professional elevator operator.

Temporary Storage

Because of rapid harvests which are mandatory for the producer to preserve his crop, we must consider the possible use of temporary storage. This may be a structure, other than the elevator, that can be used until such time as the grain can be shipped out. It may also be on the ground storage which will demand your most careful attention. The decision for using temporary storage must come from management and this decision will be made after consideration of need, availability, convenience, weather conditions, crop conditions, market conditions and terminal storage available. For this discussion, we will limit our thinking to on the ground storage as this may be of prime importance to the operation.

Very little has been written about on the ground storage of grain and most of the knowledge comes from experience. Many grain handlers have piled grain on the ground with good results from this storage. Others have had problems with this grain that have been disastrous.

The first condition for on the ground storage must be the location. Your location must be well-drained of surface water so any moisture from rain or snow will drain away from the pile. Avoid surface areas with depressions and pockets that would hold water as surface water is your main problem. Your location may be a surfaced area or it may be sodded or clear. Surface cover is not important as any surface works about the same. Consideration must be given to the job of picking the grain up for permanent placement later on, so the surface should be clear and as clean as possible.

Another consideration must be made for the actual piling of the grain. Is it convenient to the scale and elevator to facilitate the harvest and then the outward movement? Can you safeguard the pile from vandalism and pilferage? What method of piling will you use and what equipment is necessary? How will you pick it up later on? After these decisions have been made and you are actually piling the grain, the responsibility for the operation falls on your elevator men.

Grain being piled outside must be of uniform moisture and quality. Moisture is the greatest problem you will be confronted with. Trouble spots, caused by wet loads, will develop quickly in a pile of grain, so uniformity in moisture is the key to success. Blending may be needed to assure this uniformity, but be very sure there are no high moisture spots in the pile.

The natural slope of the grain pile will shed water very well. Experienced men will tell you there is very little concern about rain or snow in a well formed pile. Just as the slanting roof of a tent will shed water, so also will the top of the pile shed water. Saturation from the top will be no more than a couple of inches and this will dry out quickly, when the rain ceases, due to natural aeration.

A word of caution now in regards to the piling process. You must not have pockets or depressions in the surface of the pile as this will hold water from draining off. Water not able to drain off will naturally go down into your grain, causing spoilage and heating. Even small depressions caused by footprints must be avoided as these are potential problem causes.

After your grain pile is formed, your responsibility is to protect it from loss. Watch it well to avoid damage. Children must not be allowed to play on or around it, as this can soon disturb the natural water shedding action. Vandalism and pilferage must be controlled closely also.

Binning for Effective Control

Harvest time is not only the time that you can provide efficient service for your patron, but is also, the best possible time to acquire grain stocks for storage and for sale. Your responsibility to your patrons is to preserve the qualities delivered. Management of space for quality, test weight, moisture, foreign material, dockage, etc. segregation, is your responsibility. This will permit efficient conditioning for quality control after harvest which will reduce marketing costs, perserve quality values and return larger receipts to the producer.

When grain arrives at your elevator, what determines what you do? Control over your inventory in the elevator begins with the unloading of the truck. Grain should be segregated by type and quality. Type shoul be no problem, unless the pit is not clear or the distributer not set properly. Quality is an entirely different matter. After receiving the required information from the office on quality factors, you can bin and segregate according to moisture, test weight, dockage, etc. How much separation by type and quality is possible depends upon the tools you have in your elevator; its size, tanks or bins available, number of legs and dump pits. The results of your pre-harvest planning are realized now during harvest.

How do you determine which bin to place the grain in? Moisture is probably the most important consideration since early harvest grain will no doubt have excessive moisture. Again, the tools you have available may determine what you do.

Do you have aeration bins?
Do you have, and use, "wet" holding bins tied into a dryer system?
When do you use the dryer?
When do you depend on aeration alone?
When do you blend wet and dry grain?

If the grain received is in a storable range in moisture, then test weight, dockage and other grade factors should be binned together as much as possible. Protein may also play a part in binning wheat, if the knowledge is available on which to base it with some degree of accurac Management policy may set this on a station average basis, which usually requires blending or mixing later and no segregation when received.

When inventory stocks can be no better than what you receive, it takes very little to cause considerable loss in value. Carelessness in operations - mixing different kinds of grain, spillage, poor housekeeping, spoilage resulting from simple neglect, and sometimes pilferage, can cause a large loss in value with the result being a loss in operations.

General Rules for Measuring Grain in Bins

1. Each cubic foot of usable space will hold .8 bushel of standard test grain.
2. The bin chart furnished by the warehouse licensing office will show the design of each bin in the elevator; its height, size, and capacity per foot of height based on a standard bushel. The total capacity of each bin and the total elevator is also given.
3. Adjustments have been made by the warehouse licensing office for tapered bin bottoms and fill spout slope. Bin height as shown on the bin chart is all usable space, after necessary adjustments.
4. Grain falling into a bin will flow from the point of impact to the outside wall of the bin. This causes a compaction of the grain, for which an adjustment must be made.
5. Compaction rates are based on standard grain qualities. Rate adjustments must be made for test, moisture, dockage, and size of bin in relation to wall area. Compaction rates must be increased for high moisture, low test weight, dockage and damaged grain. Compaction rates must be decreased for heavy test weights, low moisture and clean grain.
6. Measurements must be made from bottom side of roof slab down to top surface of grain in bin.
7. Subtract this measurement from the bin's usable height as shown on the bin chart. This would give the height of grain in the bin.
8. Multiply height of grain in the bin times the bushels per foot shown on the bin chart. The sum will show the grain inventory in the bin.
9. Make adjustments as needed for the following:
    a. Test Weight
    b. Moisture
    c. Dockage
    d. Pack

Test Weight Correction

Multiply the measured inventory by the test weight correction factor to compute the actual inventory. The following formulas should be used for their respective grains:

$$\text{Wheat -- } 100 \times \frac{\text{Test wt. of wheat in bin}}{60} = \text{percentage correction factor}$$

$$\text{Corn -- } 100 \times \frac{\text{Test wt. of corn in bin}}{56} = \text{percentage correction factor}$$

$$\text{Barley -- } 100 \times \frac{\text{Test wt. of barley in bin}}{48} = \text{percentage correction factor}$$

$$\text{Oats -- } 100 \times \frac{\text{Test wt. of oats in bin}}{32} = \text{percentage correction factor}$$

Examples

$$\text{Wheat -- } 100 \times \frac{\text{62 test wt.}}{60} = 103.33$$

$$100 \times \frac{\text{58 test wt.}}{60} = 96.667$$

Moisture Correction

Use a correction factor only if the moisture is above the minimum requirement on that particular grain. An example is as follows:

Wheat ------- 13.5% Moisture
Corn ------- 15.5% Moisture
Barley------- 14.0% Moisture
Milo ------- 14.0% Moisture

Wheat -

1. Subtract 13.5% from the actual moisture content.
2. Take the difference from 100% to get the correction factor.
3. Multiply the correction factor times the bushels in the bin.

Dockage Correction

This is only calculated if there is a percentage of material that can be mechanically separated from the grain. This percentage figure is put on by an official grain grader.

a) 100.00% minus dockage % = correction %

b) Correction % times bushels in bin = actual grain inventory

Example

100.00% - 0.5 dockage = 99.5%
99.5 % x bushels = corrected bushels

Pack Factor Correction

To start this correction you need to refer to Table VIII for the bin size (diameter), shape and the individual grains pack factor.

Wheat	Add to Deduct from	pack 0.3% for each pound under 60 lbs./bu. pack 0.3% for each pound over 60 lbs./bu.
Corn Sorghums	Add to Deduct from	pack 0.3% for each pound under 56 lbs./bu. pack 0.3% for each pound over 56 lbs./bu.
Barley	Add to Deduct from	pack 0.5% for each pound under 48 lbs./bu. pack 0.5% for each pound over 48 lbs./bu.
Oats	Add to Deduct from	pack 1.0% for each pound under 32 lbs./bu. pack 1.0% for each pound over 32 lbs./bu.

In practice, it may be necessary to apply barley percentage adjustments to oats of unusually high test weight; the same principle applies to other grain of unusually high or low test weight.

For grain not shown on the chart, the table for grain nearest the same test weight and characteristics should be used. For example, Sudan Seed inventories can be made by using the Barley table; Soybean and Dry Bean inventories can be made by using the Corn table.

a) Wheat - (21 foot bin and 7.0% pack factor)

1. Each pound under 60 add 0.3%
2. Each pound over 60 subtract 0.3%

Based on test weight

3. Multiply the number of pounds by 0.3
4. Add or subtract the correction to 7.0%
5. Add the pack factor correction to 100 and multiply times the bushels in bin.

Example: Wheat tested 60.4#/bushel

0.4 x 0.3 = .12

7.0 - .12 = 6.88 corrected pack factor

106.88 x bushels = corrected inventory

Notes on Special Situations

Moisture appears to have an effect on the packing, the higher the moisture, the greater the packing; however, until further studies are made, it should be disregarded.

Depth of bins and settling over a period of time are negligible factors. The examiner should not confront himself with time factors he cannot adequately check.

With the longest distance in cross section of the bin being the controlling factor, maximum pack may be caused solely due to this factor, irrespective of other factors. In shallow bins of large cross section where the peaks are not over 20 or 25 feet high, there may be an exception to the general rule.

Vibration caused by machinery, within the structure, causes excess pack, the pack being greatest near the source.

Another packing factor is the area in the bin over which the grain falls. The greater the area in comparison to the total area, the greater the pack within the maximum, which in wheat, appears to be about 10% in dry 60 pound wheat.

Oats are the most difficult of grains to inventory, especially light weight, rough, chaffy oats, such as Red Oats as raised in Texas, which sometimes pack as much as 40% in a 18-foot tank.

Types of building material need not be considered, as at most the effect could be only one kernel deep at the wall.

Without accurate bin capacities, accurate determination of distance to grain, accurate samples, correct test weights, satisfactory inventories are the result of the chance.

Inventory Problem

Using the correction factors previously discussed, calculate the number of bushels of grain in each of the following bins. Use the included tables when needed.

1. Bin #1 - Wheat

Diameter 25 ft. - Round Bin
Usable height 105.5 ft.
Capacity per ft. - 293.0 Bu.

Grain Information
62.5 Test Wt.
1% Foreign Material
.9% Dockage
14.3% Moisture
Inside Measurement 83 ft. 3 inches

How many Bushel of wheat are in this bin? (use 2 decimal places)

2. Bin #2 - Yellow Corn

Diameter 30 ft. - ◇ shape
Usable height 105.5 ft.
Capacity per ft. 183 Bu.

Grain Information
54# Test Wt.
18% Moisture
1.75% Dockage
Inside Measurement 18 ft. 8 inches

How many Bushel of corn are in this bin? (use 2 decimal places)

TABLE VIII

TENTATIVELY RECOMMENDED PACKING PERCENTAGES FOR MEASURED GRAIN INVENTORIES: REVISED OCTOBER, 1949

STANDARD CONCRETE CONSTRUCTION WITH TANK DIAMETER AS BASIS FOR DIMENSIONS

A – B – C – D

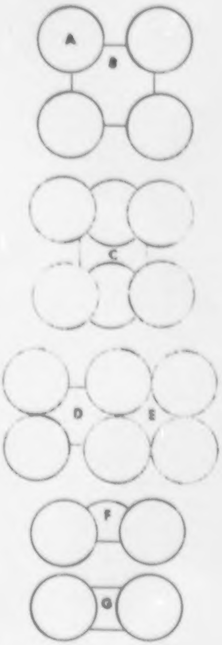
Dia.	Wheat W/Oat Dkg.	60.0 Wheat	56.0 Corn	32.0 Oats	56.0 Milo	48.0 Barley
35.0	8.0	10.0	7.0	40.0	9.0	25.0
30.0	7.0	9.0	6.5	36.0	8.0	22.0
25.0	6.0	8.0	6.0	32.0	7.0	20.0
23.0	5.5	7.5	5.5	30.0	6.5	18.5
21.0	5.0	7.0	5.0	28.0	6.0	17.0
18.0	4.0	6.0	4.5	25.0	5.5	16.0
15.0	3.5	5.5	4.0	22.0	4.5	14.0
12.0	3.0	5.0	3.0	20.0	3.5	12.0

E – F

35.0	5.0	6.5	4.5	28.0	5.0	15.0
30.0	4.5	6.0	4.3	25.0	4.7	14.0
25.0	4.0	5.5	4.0	24.0	4.2	13.0
23.0	3.5	5.2	3.8	22.0	4.0	12.0
21.0	3.5	5.0	3.5	20.0	3.8	11.0
18.0	3.0	4.5	3.0	18.0	3.3	10.0
15.0	2.5	4.2	2.5	16.0	2.8	9.0
12.0	2.0	4.0	2.0	14.0	2.3	8.0

G

35.0	4.5	6.0	4.0	27.0	4.0	14.0
30.0	4.3	5.0	3.8	25.0	3.7	13.0
25.0	3.0	4.7	3.0	23.0	3.3	12.5
23.0	2.7	4.5	2.8	21.0	3.1	12.0
21.0	2.5	4.3	2.5	19.0	2.9	10.5
18.0	2.2	4.0	2.3	17.0	2.7	9.5
15.0	1.9	3.5	2.0	15.0	2.3	8.0
12.0	1.5	3.0	1.8	13.0	2.0	7.5



RECTANGULAR BINS

B/Ft.		Wheat Small Crib Head House	Wheat W/Dkg.	60.0 Wheat	56.0 Corn	32.0 Oats	56.0 Milo	48.0 Barley
19.3	4 X 6	4.0	1.5	2.0	1.5	12.0	2.0	5.0
28.9	6 X 6	4.5	1.8	2.5	1.7	13.0	2.4	5.5
38.6	6 X 8	6.5	2.0	3.0	2.0	14.0	2.7	6.0
51.4	8 X 8	7.5	2.3	4.5	2.3	15.0	2.8	6.5
64.3	8 X 10	8.5	2.5	5.0	2.5	16.0	3.0	7.0
77.2	8 X 12	9.0	2.8	5.5	3.0	17.0	3.5	7.5
90.0	8 X 14	9.5	3.0	5.8	3.5	18.0	4.0	8.0
128.6	8 X 20	10.0	4.5	6.5	5.0	26.0	5.5	11.0

CHAPTER VII

ELEVATOR MAINTENANCE

CHAPTER OBJECTIVES

After the completion of this chapter the student should be able to:

1. Identify and name elevator equipment and machinery used in the handling of grain.
2. Follow a suggested monthly preventive maintenance program.
3. Complete a checklist of activities that contribute to good elevator maintenance.
4. Observe a maintenance inspection of truck hoist, caged man-lift, bucket elevators and grain dryers and adequately list or explain what took place.
5. List types of greases and lubricants used in elevators.

TEACHING AIDS

1. Slides of Elevator Facilities - Far-Mar-Co., Inc., Hutchinson, Kansas.
2. Kansas State University Publications on Maintenance: MF - 121 Prevention of Fire and Dust Explosions, Manhattan, Kansas.
3. Hand-outs of Suggested Maintenance Schedules: B-226S Eng Bulletin Bearings and their Lubricants, Standard Oil Company.
4. Discarded elevator equipment and manufacturers samples.
5. Grease and Lubricant Manuals.

STUDENT ACTIVITIES

1. Field trip to elevator to observe good maintenance.
2. Field Study Period
   - a) Change buckets on the bucket elevator
   - b) Complete a maintenance checklist inspection of a country elevator.

SUPPLEMENTAL REFERENCES:

1. Midwest Plan Service Structures and Environment Handbook.
2. Bearings and their Lubricants by Standard Oil B-226S.
3. Co-op Grease and Lubricants by Farmland Industries K.E.M.

STUDENT STUDY GUIDE

The following terms and questions should be answered from either the enclosed Technical and Instructional Material or Supplemental References.

Preventative Maintenance -

Bucket Elevators -

Lagging -

Cage Manlift -

Belt Manlift -

Head Pulley -

Tail Pulley -

Gear Reducers -

Lap Splice -

Butt-Rider Splice -

Strobing -

STUDY QUESTIONS

1. Explain or define in brief terms what is meant by a preventative maintenance program.

2. List three different types of grease or oil lubricants recommended by equipment manufactures.

3. Why is a pre-harvest maintenance check list so important?

4. List 12 different pieces of equipment that require maintenance checks and give at least one inspection function that should be performed. (Example: Spouting - check for cracks and holes.)

5. Analyze and explain why preventative maintenance is a continuous program.

6. Why should manufactures recommendations be followed?

7. Explain the statement, "The most expensive equipment is always the cheapest."

8. Give a good rule of thumb on how tight U-belts should be tightened.

9. What is the single most important piece of equipment in the elevator? Explain why and name four major parts of that piece of equipment.

10. List three different types of belt splices used in bucket elevators.

11. Explain the difference between any two types of belt joints ask for in question # 10.

12. Give three reasons for a leg belt not running on the center of the leg pulleys?

TECHNICAL AND INSTRUCTIONAL MATERIAL

Country elevators have heavy seasonal demands on its machinery. Long, demanding hours soon take its toll and fatigued equipment. Machinery that has been neglected will fail quicker and will generally be more expensive to repair. The additional expense comes from seizing or shattering of parts under load and from loss of time.

Untimely breakdowns cannot be totally eliminated, but through a carefully planned preventative maintenance program breakdowns can be cut to a minimum.

Because no two elevators operator exactly alike nor under the same load requirements specific instructions for preventive maintenance is impractical. However, with an approximate time schedule and good common sense a strong program can be developed. A careful eye and a sensitive ear will do as much for good maintenance practices as will a specific time table.

An important issue to remember is that we cannot trust our memory when it comes to preventive maintenance. There are far too many adjustments, sizes, lubricatns and specifications to remember without assistance. Some means of recording the information must be accomplished. A record book, maintenance schedules or a daily log should be kept.

Obviously, the greatest demand on the equipment is during harvesting and shipping operations. Both are very seasonal, and intermittent. Constant readiness is the best solution to prevent untimely breakdowns. Preventative maintenance programs offer the continuous monitoring and servicing of equipment.

Ahead of each harvest a careful check of all equipment should be made. A little extra care and time taken before harvest will pay off with handsome returns. All faulty or broken equipment is replaced preventing loss of time and perhaps an accident.

A pre-harvest check list should not only include machinery or equipment but other primary concerns such as people, fuel needs, hours of operation, consolidation of inventory and available transportation. The following checklist includes the necessary equipment and facilities that are of concern:

1. Truck Scales - Check for accuracy and proper operation.

2. Moisture Testor - Accuracy and back-up measures.

3. Elevator Housekeeping - Clean and free of dust and insects.

4. Reduce and Consolidate Inventories
5. Gear drives and bearings - Change gear lube and grease bearings.
6. Bucket Elevator - Check belt, belt splice, cups and lagging.
7. Manlift - Check cables, clamps, brakes and switches.
8. Electrical Wiring - Broken conduit, bare wires, no grounding.
9. Transferring equipment - Augers, Belts and Spouting.
10. Elevator Load-Out Scale - Accuracy and Proper Weights.
11. Truck Hoist - Mountings, brake, cable and clamps.
12. Safety Equipment - Hard hats, dust and gas masks and fire extinguishers.
13. Temperature Sensing Cables - Check controls and cable mounts.
14. Aeration Ducts - Bent or seperated ducts, holes and louvers.
15. Grain Dryer - Fuel leaks, augers, legs, electrical controls.

A preventative maintenance program is a continuous program. It should not be taken hap-hazardly but done on a routine consistent basis. Preventative maintenance might be defined as the careful and thorough lubrication, adjustment, repair and replacement of all working equipment prior to machinery failure.

In all cases, the manufactures recommendations should be followed. Intervals of service may be given in hours of operation rather than calendar day sequences. Whatever process is used for a preventative maintenance program, some type of records must be kept. The following suggestions list the major items of concern on which a file or maintenance record should be kept.

1. Purchase or replacement date and date of last service.
2. Specifications - size, dimensions and type.
3. Serial numbers
4. Suppliers name, address and phone number.
5. Owner/operators manual.

6. Date of last service and what was done.

This list of six items should be kept on every piece of equipment that requires service and maintenance. When dimensions are needed, dates are ask for or serial numbers required, immediate access to that information is helpful.

Maintenance checklist are helpful in a good maintenance program. Any format may be used to record this information. Individual forms may be designed for each facility or for each piece of equipment. The important point is that you use something other than your memory to record the essential information.

The following maintenance checklist is provided as a suggestion. Use it, add to it and make it functional for your elevator. Design a card or quick checklist of items to speed your record keeping.

Equipment: ____________ Number ____________

Location: ____________

Purchase Date: ____________ Supplier: ____________

Model Number ____________ Serial No. ____________

Lubricant Requirements: ____________

Date	Initials	Service Required	Condition		
			Exc.	Good	Poor

MAINTENANCE CHECKLIST

All equipment should undergo the following checks in an inspection.

1. General conditon of the equipment including finish and surface cleaning.
2. Mounting brackets and supports secure.
3. Proper guarding and safety shields in place.
4. Excessive noise and vibrations during operation.

In addition specific equipment must undergo additional checking and servicing. Some of those pieces of equipment are listed below, along with the item to be checked and a recommended interval.

Electricial Equipment: Use National Electrical Code.

A. Electric motors, dust tight or explosion proof.
   1. Proper grounding (visable) - monthly
   2. No exposed or bare wires - monthly
   3. Clean and free of dust - weekly
   4. Pulleys in alignment and tight - weekly
   5. Motor mounts secure - weekly
   6. Adequate lubrication (if required) - monthly

B. Lights and Conduit
   1. Globes on all lights with bump guard - daily
   2. No open or exposed recepticals or conduit junctions - semi-annual
   3. Proper and adequate mounting brackets - semi-annual
   4. Proper sizing of light bulbs in globes - at time of replacement

C. Electrical Controls and Switches (Dust tight ignition proof)
   1. Limit Switches - weekly
   2. Control Switches - weekly

3. Recepticals - weekly
4. Extension cords - prior to each use
5. Portable lights - prior to each use

Gear Boxes and Bearings:

1. Reducers - monthly (semi-annual grease change)
2. Power drives - monthly (semi-annual grease change)
3. Sealed bearings - Daily (check temperature)
4. Standard bearings - Daily (check temperatures)

Bucket Elevator:

A. Cups or buckets
   1. Cracked Cups - weekly
   2. Bent or broken - replace immediately
   3. Worn cups - semi-annually
   4. Missing or broken bolts - weekly
B. Belting
   1. Frayed edges - weekly
   2. Cracked and checking - semi-annually
   3. Carcass sponginess - semi-annually
   4. Belt splice - weekly
   5. Trueness of "running" belt - daily
   6. Adjustment of belt cake-up - As needed or semi-annually
C. Head and Tail Pulley
   1. Lagging wear - monthly
   2. Alignment and plumbness - Semi-annually or as needed.

    3. Bearing pillow blocks - weekly
    4. Spokes and Key-way - monthly
    5. Hood, throat and boot wear - annually

D. Motion Sensing Equipment - Daily

E. Fuses and relays - semi-annually or as needed

Manlifts

A. Cables and clamps
    1. Tight of clamps - monthly
    2. Proper placing of clamps - annually
    3. Cable wear - monthly
    4. Cable fraying - semi-annually
    5. Adequate sizing of cable - at time of replacement

B. Cage, Frame and guides - monthly

C. Brake operation - daily

D. Down speed governor - monthly

E. Drive pulleys and idler pulleys - semi-annually

F. Counter balance weights - semi-annually

G. Governor/brake rope or cable - monthly

H. Electrical Controls and power cord - weekly

I. Limit switches - daily with each use

Loadout Scale

A. Clean and Remove debris - prior to each use

B. Zero balance - monthly or with grain loading change

C. Leaks and Patches - monthly

D. Electrical controls and scale operation - Prior to each use

E. Spouting leaks - repair as needed

Distributor and Moisture Monitor

A. Work floor controls - monthly

B. Wear patterns - semi-annually

C. Clean and adjust - as needed

Aeration Fans

A. Clean fan blades - annually

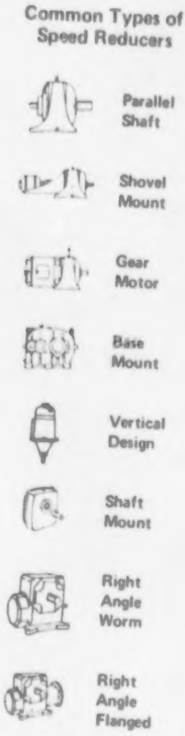
B. Electrical controls and fuses - semi-annually

C. Bearings - weekly during operation

D. Duct work - annually

Augers, screw conveyors, manlifts and flat belt conveyors will frequently use some type of a gear reducer. Elevator legs always incorporate a gear reducer to maintain the speed and torque that is required. In some elevator installations the gear reducer on the bucket elevator will have a back stop to prevent reverse rotation.

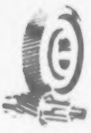
At the right are various sizes and shapes of gear reducers used in power drives.

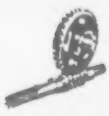

Common Types of Speed Reducers

Parallel Shaft
Shovel Mount
Gear Motor
Base Mount
Vertical Design
Shaft Mount
Right Angle Worm
Right Angle Flanged

Gear reducers come in a wide variety of shapes

Gear reducers not only reduce the speed to maintain torque but may also change the direction of the output shaft vs. input. Such is the case pictured at the right. Helical gears change direction of rotation and worm gears make 90 degree turns.


HELICAL GEARS


WORM GEARS

Important Information

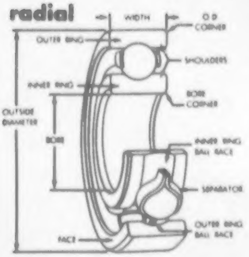
in connection with handling Bearings

It is estimated that more than 90% of all bearing failures are caused by abrasive particles that get into the bearing BEFORE installation. This means that extreme care should be taken in handling bearings before and during installation. The following points should be kept in mind . . .

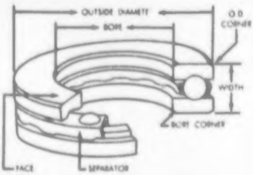
- ★ Keep bearings in original cartons and wrappings until ready to mount.
- ★ Treat a used bearing as carefully as a new one.
- ★ Clean hands and clean, lint-free rags mean cleaner bearings . . . less chance of corrosion from perspiration.
- ★ Work with clean tools in clean surroundings.
- ★ Clean inside of housing before installing new bearing or replacing used bearing. DO NOT WASH new bearings before installation.
- ★ Check shaft and housing for burrs.
- ★ Don't spin uncleaned bearings and don't spin any bearings with compressed air.
- ★ Be sure to use the correct lubricant in the right amount.

BALL BEARINGS

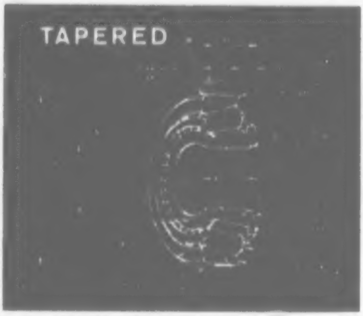
radial

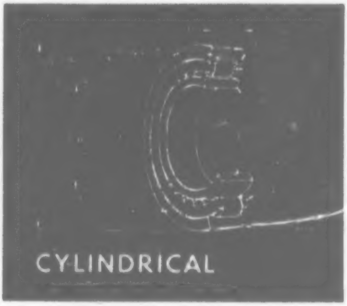

WIDTH
O.D CORNER
OUTER RING
SHOULDERS
INNER RING
BORE CORNER
OUTSIDE DIAMETER
BORE
INNER RING BALL RACE
SEPARATOR
OUTER RING BALL RACE
FACE

thrust


OUTSIDE DIAMETE
BORE
O.D CORNER
WIDTH
BORE CORNER
FACE
SEPARATOR

ROLLER BEARINGS




CYLINDRICAL

Adjustment and Lubrication

Several tips or "rules of thumb" will frequently provide adequate maintenance in absence of proper instruction or a owner/operators manual.

In all cases because of down time, replacement cost and length of service, the highest quality equipment is the lease expensive. Or, it might be said the "most expensive is the cheapest." Obviously the longer machinery last and the more bushels it can handle the per unit cost are reduced.

A good, reputable lithium base grease is a must for proper lubrication of bearings. (Use electrical grease for motors) Too much grease at one time or too frequent greasing intervals will overload a sealed bearing and rupture the seals. If the seals remain in tack, excessive pressures build up internally causing overheating and seal rupture. Too much grease can be as harmful as inadequate lubrication.

If the frequency or amount of grease is in doubt here are two suggestions.

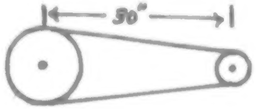
(1) A one inch pillow block bearing has a maximum capacity of 1/4 ounce of grease - two pumps of the standard grease gun handle.

(2) Pump a limited supply of grease into the bearing. Thoroughly clean the area. Remove the grease zerk after 3 or 4 rotations of the shaft. This allows the excess grease to expand out of the opening rather than rupture the seals. BE SURE MACHINERY IS SHUT DOWN!! Do not work on moving machinery. Note the amount of grease that squeezes back out in comparison to one grease gun shot. Adjust your greasing practices accordingly.

V-belt adjustments are based upon adequate tension. If slippage occurs after properly tightening the belt(s) DO NOT ADD belt dressings. Belt dressings are only temporary and cause a build up of material in the bottom of the pulley belt groove. Secondly, the contact surface of the belt becomes hard and slick loosing friction. If the proper width V-belt has been selected, the only other alternative to prevent slippage is to reduce size or go to a multiple belt drive system.

Adequate tension can be measured by a rule of thumb. Measure the distance between pulley centers. For every 12 inches of distance measured, you should be able to depress the belt 1/4 - 3/8 inch.

Example:



$\frac{30}{12} = 2.5$ (2½) 2.5 X .25 inches = 5/8 inch depression

Another area of maintenance generally given to the elevator man is "patch and fix-up". Patching and fixing leaky roofs, broken windows, and worn out spouting get to be an endless job. Your efforts at patching is only a maintenance "first aid" rather than a permanent cure.

Replacing window glass with a clear plastic will eventually reduce the problem of breakage. Windows must be kept in place, however to keep birds and rodents out of the elevator. Sufficient rodent and bird filth found in grain will bring about an inspection by pure food and drug administration and the State Department of Health.

Worn and leaking spouts are the trademark of an older elevator. Patching spouts is a troublesome task. To the elevator man the problem always gets worse before it gets better. The only real cure for worn out spouting is to replace it. In order to reduce the housekeeping problem a spout must receive immediate attention. An unattended small hole will within hours turn into a gaping hole large enough to drop a golfball through. Grain will literally pour through the opening.

Several commercial products are available for patching spouts. Some quick and temporary repairs are using duct tape, strapping rubber inner-tube or belting over the holes. More permanent patching material is auto-body putty, special resins and epoxys and gluing rubber or vinyl patches in place. Most permanent of repairs is to patch the spouting with similar material and screw or weld the metal in place. More recently liners are being placed inside spouting or spouting is made to unbolt and turn 1/4 revolution to provide extended life.

Water leaks are a serious threat to the elevator operator. It not only is a nuisiance but a hazard to maintaining the grain quality. Cracks develop in roof seams and construction joints. Wherever expansion and contraction cause separations moisture will enter. Snow and standing water on a flat roof always find a way to penetrate roofing material. Bubbles will form and cause separation of the roof. A careful monthly inspection of the roof is adequate to keep leaks in check. Finally sufficient weakness will require the services of a roofing contractor to replace the roof.

Underground seapage allows tunnels and pits to fill with water, especially during the wet spring and summer. Drifting and melting snow will also allow moisture penetration in these areas. Well graded and drained soil around an elevator is a must. Heavy rain water must be able to drain away. Additional dirt may need to be placed near the elevator and leveled to correct settling and erosion problems.

Making adjustments and keeping records on the bucket elevator is a critical responsibility of the elevator operator. If the "leg" or bucket elevator fails for any reason, the elevator is virtually shut down. The only activity that can continue is the process of loading trucks from overhead bins.

Think of the leg belt as a giant rubber band. What happens to the rubber band as it stretches? It first of all gets longer and second it gets thinner or narrower. With these two ideas in mind measurements of the leg belt are important. If the original measurements are not recorded contact the manufacturer. Then compare annual measurements of the width and thickness. Any pieces removed should also have their length recorded to indicate the amount of stretch. Buckets should be removed at random intervals to look for wear patterns and bolt hole elongation.

A good belt that is properly cared for and maintained in adjustment should last 20 (+) years. Warning signs that a belt is fatiguing are:

(1) Sudden stretching or difficulty in maintaining alignment. Several adjustments needed in succession.

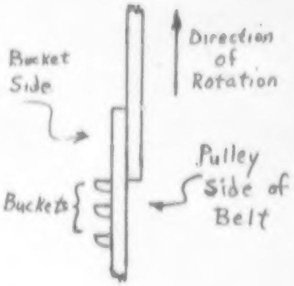
(2) Continued loss of buckets for no apparent reason other than bolts pulling through the belt.

(3) A softness or spongy feeling to the belt carcass rather than a stiffness and firmness .

The splice in the leg belt is a critical link in the strength and longevity of the belt. Three types of belt splices are generally used in the industry.

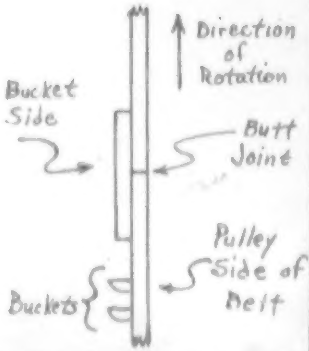
a) Lap Splice:

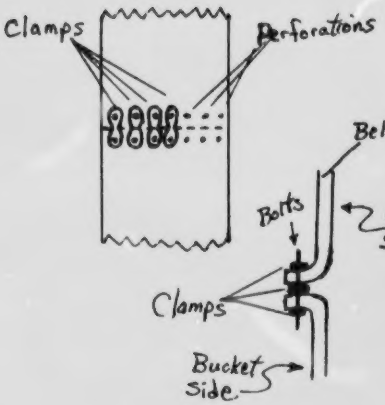
This is the process of simply placing one end of the belt on top of the other end. One end "laps" over onto the opposite end forming the endless belt. An important consideration is that the overlapping piece should be on the outside (bucket side) of the belt loop.



b) Butt-Rider Splice:

This splice brings the two ends of the belt together. A second piece of material (same as belt) is placed over the junction of the two ends (on the bucket side). The two ends are butted together and a second piece rides over and joins the belt together in a continuous loop.





c) Mechanical Fasteners

Two types of mechnical fasteners are available on the market. Both fasteners are commercially produced. One requires hole perforations along both edges of the belt and butted together held in place by figure 8 clamps.

The other style of fastener draws the belt together in a butt joint and pinches the ends in a clothes pin fashion.

Both the lap slice and the butt-rider splice requires a minimum amount of belt contact to maintain its strength. The butt-rider splice requires twice the amount of total belt material as the lap splice. This belt distance is generally stated or measured in numbers of buckets. (Buckets are on a 9 or 10 inch spacing for many belts) To maintain the maximum strength of the belt its total elevating height is considered. The required number of buckets for the splice is stated then against the height of the leg.

Height	Lap Splice	Butt Splice
0 - 99	3	6
100 - 149	4	8
150 - 199	5	10
200 - 249	6	12
250 - 299	7	14

Essentially what the chart shows is that the butt-rider splice actually required twice the buckets.

From looking at the diagram you can see that a butt-rider joint is two lap joints placed end to end.

Since the elevator leg is the most important piece of equipment in the elevator, special attention should be given to its care and maintenance. In addition to the routine thorough checks made on the leg spot checks should be made. The quickest and easiest way to make several of these checks is with an electric strobe light.

Strobing a bucket elevator can have several advantages. A bright intense flashing light is directed at the buckets on the leg belt and the frequency adjusted to observe the equipment in operation. During this interval the buckets literally appear to be standing still even though they are in motion. WARNING - Do not extend tools or hands into the leg opening during strobing process!

Several visual checks are made on the buckets and belt during strobing. The amount of grain filling each cup can be observed in relationship to the Ampheres being drawn on the gauge. Bent, cracked or missing buckets can be readily detected during this process. Missing bolts are also spotted.

Other checks that should be made on the bucket elevator or leg during an inspection are listed below.

(1) Periodically remove buckets at random and check the wear pattern behind the bucket. A small worn groove in the belt at the top-backside of the bucekt is natural. However excessive wear indicates improper sizing, improper spacing or a belt with considerable age and wear that will need replacing. Also while the bucket is off check the bolt holes for elongation and excessive wear. Too large of holes will indicate loose buckets, excessive digging and scraping or possibly a softening of the belt prior to stretching and separation.

(2) Take random thickness and width measurements of the belt. These measurements will decrease as the belt ages and stretches. Each time the belt is shortened and a section is removed keep a record of the length of piece removed.

(3) Look at the backside of the belt for wear patterns and friction burns - slick spots. Also observe the heads of the bucket bolts to be sure they are flush and drawn down tightly into the belt.

(4) Watch for ragged and frayed edges on the belt indicating rubbing on the sides of the leg well. Correcting the belt alignment generally aleviates this problem.

(5) Belt Splice or Belt Joint. This portion of the leg belt receives more stress than any other. The double thickness of the material decreases the belt's ability to flex. As the contour of the belt changes going over the head and tail pulley a stress is put on the bolts and belting. Frequently the bolts will snap or break in half causing a weakness in the belt splice.

(6) Head Pulley or Drive Pulley Lagging. To help maintain surface friction and prevent belt slippage the surface of the top pulley is covered. The material used to cover the flat surface is very similar to the belting. The lagging is bolted to the drive pulley and must be replaced periodically as it wears smooth.

(7) Alignment of the head and tail pulleys. Generally the drive pulleys on a bucket elevator are crowned or raised slightly in the middle. The elevated portion of the pulley is generally no more than ¼ inch and is used to train the belt and maintain alignment. If the belt runs to one side sequentially check the following probably causes.

-- The belt is too loose and needs tightening.

-- A worn or loose bearing on either pulley

-- Elevator has shifted its position and the belt needs to be realigned.

-- The belt has been overloaded and shifted its position. Regardless of the reason, the belt must be realigned and centered on the pulleys. This is done by raising or lowering the take-up screws on the tail pulley assembly.

Sloppy maintenance will find you out, but the quickest way to cause an accident or unnecessary down time is to let the bucket elevator go unattended. There are no short cuts or easy ways to adequately care for the leg. Take the time to do the job right. Keep the leg in tip-top condition.

Whenever debris has been dumped into the pit and catches on the buckets immediate shut down is required. The same is true if the bucket elevator chokes or becomes plugged. Remove the debris, replace the damaged cups, go to the top of the leg and check for hot or overheated belt and lagging, clean out the excess grain from the leg chamber and start up the equipment again.

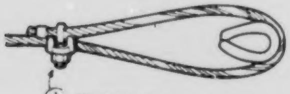
Two new features are now installed on many bucket elevators to prevent some hazards. These are the motion sensing devices and magnets. Motion sensing devices monitor the rotating motion of the leg belt. If the belt speed slows or retards in excess of 15% an alarm will sound. If the speed is not regained within a limited number of seconds the equipment will shut off the leg. The second piece of equipment is the magnet place ahead of the leg to remove tramp metal and foreign objects. Both of these pieces of equipment are designed to make the elevator safer and increase the working life of the bucket elevator.

Cables and Clamps

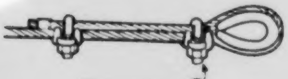
There is a great deal of confusion when dealing with wire rope (cable) and attaching wire rope clips (clamps). Only one correct way provides maximum strength and security when dealing with cables. Many false methods have been used to attach clamps to the cable and erroneous information has been offered as an explanation for the number of camps required.

Two types of clips are satisfactory for securing the end of the cable. A double saddle clamp or a U-bolt clamp are acceptable and should be of drop-forge construction. A clever way to remember which direction to mount the clips is a saying that has reference to the saddle portion of the clip. "Never saddle a dead horse." The turned back cable or pit-tail portion is the "dead-end". Do not place the saddle portion of the clamp over this part of the cable. (See diagram below.) The U-bolt tends to cut into the cable and distort its shape. Consequently the maximum strength of the cable is lost.

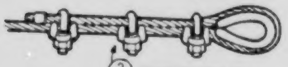
ATTACHING BY CLIPPING



① Attach first clip

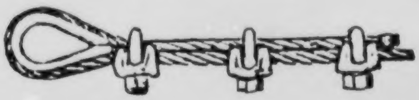


Attach second clip ②

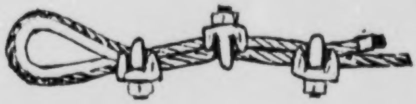


③ Attach all other clips (if required)

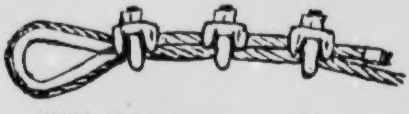
Find the number of U-bolt connectors you'll need from the table below. Attach them by following the sequence shown



RIGHT WAY for maximum rope strength



WRONG WAY - clips staggered



WRONG WAY - clips reversed

Always place the saddle portion of the clamp over the long cable which will have the load pulling against it. Place the U-bolt over the short turned back portion of the cable. The proper sequence to attach the cable clips is also shown in the diagram. The middle clips should be attached last.

Step 1: Attach the first clip at the loose end of the cable. Allow approximately 2½ - 3 inches of cable to extend beyond the saddle portion of the clip and snug the bolts tight.

Step 2: Place the second clip over the cable ends and loosely secure the bolts so the clamp can move freely. Place the thimble (metal eye) in the cable loop and slide the clamp into position against the thimble loop. Snug the bolts but do not completely tighten.

Step 3: Attach the remaining required clips between the first two at equal intervals. Again snug the bolts but do not completely tighten.

Step 4: Put the cable under light load to equalize the tension on both pieces of cable between the 1st clamp and the thimble. While the cable is under a light load tighten all bolts on the clamps. Be sure that the base of the saddle rest on the long or main cable and the U-bolt is on the short end.

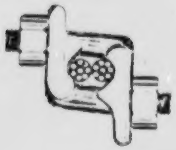
Step 5: After the cable has been in use a short time, recheck the clamps, tighten the bolts and inspect the cable for stretching or unnecessary distortion.

The following table provides the necessary information for proper sizing and spacing of cable clamps. The distance between clamps and the length of the turnback portion is also given.

Diameter of Cable	Number of Clips	Space between Clips	Length of Cable Turn-back
3/8"	2	2¼"	5"
1/2"	3	3"	9"
5/8"	3	3¼"	11"
3/4"	4	4½"	18"
7/8"	4	5¼"	21"
1"	4	6"	24"
1¼"	5	8"	40"

Wire rope or cable is used in several places around the grain elevator. Take note of these locations and include them in your preventative maintenance program.

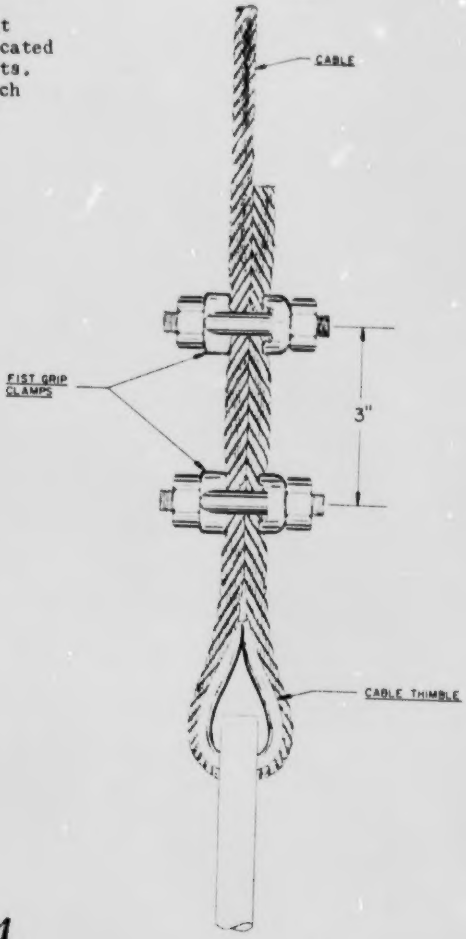
-Man lift
-Truck hoist
-Railroad Car Puller
-Winches



Fist Grip
Cable Clamp

This type of cable clamp is used by the Sidney Line, Manufacutres of caged manlifts.

The picture at the right shows the cable rigging located on top of the caged manlifts. Sidney uses two (2) 3/8 inch cables for the single man manlift.


CABLE
FIST GRIP CLAMPS
3"
CABLE THIMBLE

CHAPTER VIII

Grain Shipments

CHAPTER OBJECTIVES

After the completion of this chapter the student should be able to:

1. Better understand loading instruction and procedures of trucks and railroad cars.
2. Prepare trucks and railroad cars for loading.
3. Learn ways of eliminating loss of grain while in transit.
4. Develop an understanding of costs involved in freight rates and transportation expenses.
5. Understand the procedure for using truck and railroad bills of lading.

TEACHING AIDS

1. Copy of R.R. bill of lading.
2. Copy of truck bill of lading.
3. Sample of inspection and weighing certificate.
4. Table of published freight rates for local area.
5. Visit an elevator to observe loading of trucks and railroad cars.

SUPPLEMENTAL REFERENCES:

1. "Instruction for Installing Grain Doors."
2. I.C.C. published tariffs and regulations.
3. Transportation I, Volume I by Owens.
4. Transportation II and III by Knorst - Owens.
5. Modern Transportation Economics by Hugh S. Norton.

STUDENT STUDY GUIDE

The following terms and questions should be answered from either the enclosed Technical and Instructional Materials or Supplemental References.

Hopper cars -

Box cars -

Claims chart -

Flat rate -

Through rate -

Balance of through rate -

Proportional rate -

Terminal elevator -

STUDY QUESTIONS

1. What is the primary function of an elevator?

2. List the types of equipment used by elevators to ship grain?

   a.

   b.

   c.

   d.

3. List the general information needed for the proper loading of grain.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

4. The allowed shrinkage of grain when shipping by rail is __ of __%.

5. List and distinguish between the four different rail rates.

   a.

   b.

   c.

   d.

TECHNICAL AND INSTRUCTIONAL MATERIAL

Introduction

It has been stated that the primary purpose of an elevator is to market farm production. This marketing process involves the movement of grain from the production area into the population centers where we find the major area of consumption.

The efficiency of our marketing function greatly depends on the availability of transportation equipment. You will be called upon to ship grain out, using various modes of transportation that are available at the time and according to the conditions as stated in your sales agreement. We then, must be equipped to load all types of equipment such as, RR box cars, RR hopper cars, trucks and perhaps even barges.

Your responsibility is to reduce the cost of shipping as much as possible. You, thereby, increase the efficiency of your elevator.

Proper Loading Instructions

Because of the official grades being established on grain as it moves into marketing channels, it is necessary that grain handling employees know the quality of the grain loaded out. They must load grain to conform with sales or loading agreements; using information obtained from bin charts, inventory records, load out scale tickets, etc. The manager must instruct his elevator personnel carefully, being sure that they fully understand and will comply with his instruction.

Information needed for proper loading would include the following:

1. Type, kind and quality of grain to be loaded.
2. Amount to be loaded.
3. Date to be loaded, or completed.
4. Type of transportation equipment to be loaded.
5. Blending instructions.
6. Weighing instructions.
7. Other special instructions.

Preparations for Loading Trucks

The following is a list of the general information that should be known by the elevator employee before he starts to load a truck.

1. Grain to be loaded
    a. type
    b. kind
    c. quality

   d. bin number or numbers to load from
2. Amount to be loaded
   a. bushels
   b. truck loads
3. Date to be loaded
   a. time of day (a.m. or p.m.)
4. Blending instructions
5. Weighing instructions
6. Other special instructions
   a. load pick-up orders from truckers
   b. after hours loading - weekend loading
   c. cash on delivery - check - draft - cash
   d. information on trucker - who - how - where
   e. bill of lading - truck tickets
   f. personal information on drives - chauffer's license
7. Actual loading of trucks
   In the elevator this merely involves the opening of the right spouts and telling the truck drivers when to pull up as he drives the length of the truck under the spout to fill the truck. Every truck driver has his own instructions on how his truck should be loaded so follow them as best you [illegible] Experience is the best teacher in this area.

Preparations for Loading Railroad Cars

Because of marketing in large quantities, most of the local elevators are located on a railroad and this is the common means of transportation. Many problems have developed in rail transportation through the years and the service is sometimes poor and sporadic. The grain handler will find that certain procedures to follow will ease the situation and a better working relationship will develop between him and the railroad agents. He will also find that due to the shortage of railroad cars, his elevator will be asked to use poor, inadequate equipment. The elevator employees must use extreme care in preparing equipment for loading to assure safe arrival at the terminal. Shortages do occur during transportation, and how you have prepared the car for loading is important in proper settlement of a claim.

It also becomes important the the elevator load-out scale is functioning properly and weighing accurately. The load-out scale should be checked and calibrated by a qualified technician at least once per year. The elevator employees then must keep it clean and in good working order. Proper claim settlements are also dependent on records of scale experience at the elevator. Be sure your scale is balanced and functioning properly, has the correct amount of counter-balance weights in the box, is kept clean and free of obstructions, and that the counter device is working correctly. Periodic inspection of the load-out scale by the manager is desired to assure proper scale operation. He should want to do this as his load-out scale is the primary measure of grain going out of the elevator. A complete record of load-out scale performance should be kept in the office for future reference when settling claims for loss in transit.

A suggested procedure to follow when arranging railroad transportation is as follows:

1. Submit a written request to the railroad agent giving kind and number of cars wanted, date wanted, where and when the grain will be shipped, what the cars will be loaded with and how they will be billed. You should also state if you will accept substitute equipment and what kind of cars you will accept as a substitute.
2. Make a thorough and careful inspection of the equipment when it reaches your elevator. Check for roof leaks, holes in floor, ends and sides, loose flooring, tight liners, door posts, good storm doors, latches and locks on box cars, and good, weatherproof covers on hopper cars, and serviceable hopper bottoms, gates, latches and locks. Any car that is questionable should be refused and returned to the railroad for repair.
3. Clean and prepare the car for loading, making sure that all refuse, dirt, rotten grain, etc. is removed before loading.
4. Properly install grain doors, including the use of extension bands. This is extremely essential if the car has bad door posts, rotten, splintered, missing, etc.
5. Load car with correct weight as indicated by load limits on the car. Do not overload.
6. After loading, check for leaks, using a rubber mallet on the sides of the car. Carefully stop all leaks, or if this is not possible, consult your agent and make a notation on the bill of lading that the car is leaking.
7. Seal car properly after closing all openings and record seal numbers on shipping records.
8. Record loading information on scale tickets and submit to office for handling and billing.

Eliminating Loss in Transit

Should you have a loss in transit on rail shipments, you can file a claim to recover this loss. The standard allowed shrinkage is ¼ of 1.0%. Some companies perform this service for the local elevators and their trained staff will assist in negotiating claims. Proper procedures for loading, as previously discussed, will serve to support your claim. The information listed on the Claims Chart is what is required if one submits a loss in transit to the railroad. Settlements are made for various percentages, depending on the reason for the loss.

CLAIMS CHART

Allowed: 1/4 of 1.0% shrinkage

Claims:

1. Copy of weight certificate to include--
   - a. Car initial and number.
   - b. Date and time of weighing (unloading).
   - c. Kind of grain loaded.
   - d. Number of drafts and the weight of each.
   - e. Total scale weight.
   - f. Type and number of the loading scale.
   - g. Scale is unsupervised.
2. Defective car condition (s) on file--
   - a. Must file in writing with railroad.
   - b. File on defective car should be done when car is placed or prior to loading.
   - c. Open top liner.
   - d. Deteriorate door parts.
   - e. Grain doors which cannot be secured by use of retention straps.
3. Shipper Bill of Lading to include--
   - a. Commodity.
   - b. Complete seal record.
   - c. Scale start and stop.
   - d. Type of scale used.
   - e. Number of drafts.
   - f. Weight of each draft.
   - g. LFVC
   - h. Hopper loaded to within 12" of roof or maximum.
   - i. SWLC
   - j. Box door paper-wood.
   - k. Retention straps used.

FREIGHT RATES AND TRANSIT PRIVILEGES

Grain production must take place where the resources are available, but transportation and its costs can determine the degree to which production is developed and what particular crops will be grown.

Likewise, processors and users of grain locate where they do because of transportation rates. Plants locate near the source of raw material if large reductions in weight take place in processing or if rates are less on finished goods than on raw material.

Plants will locate near consuming areas if little or no weight reduction takes place in processing or rates are lower on raw material than on finished products.

Rail transportation dominates the movement of grain from the country to the market place. Rail transportation charges or rates, as they are commonly known, are a critical factor in the marketing of grain. Rates are published by the railroads in tariffs and are classified as -- flat rate, proportional rate, through rate, balance of through rate.

Flat Rate - A rate published from an origin (country elevator) to a transit point (terminal elevator) and/or a rate published from a transit point (terminal elevator) to ultimate market destination. See Figures I & II

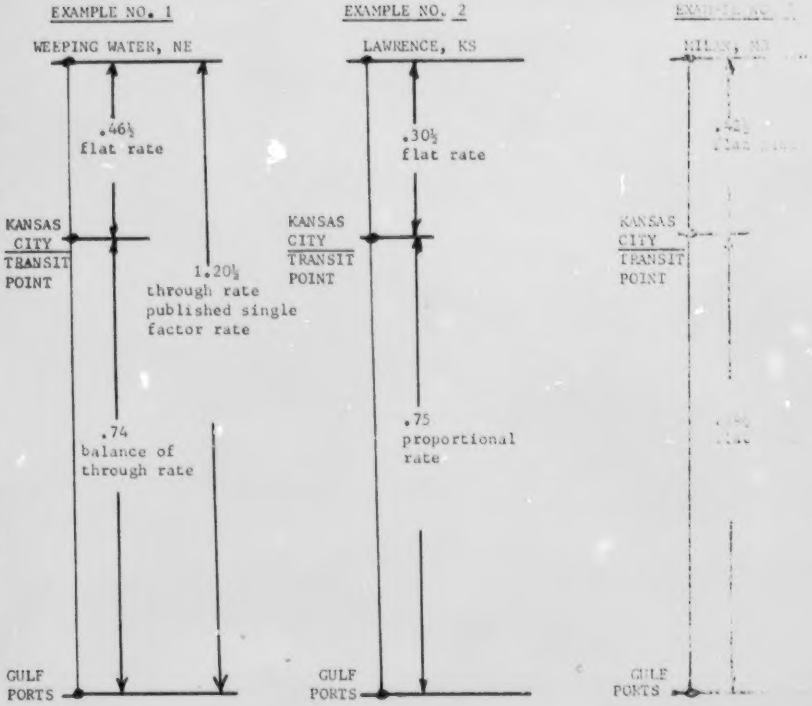
Through Rate - Rate charges from origin (country elevator) to the ultimate market destination. It may be a single factor rate or combination of two rates. See Figures III, IV, & V

Balance of Through Rate - The difference between a single factor through rate and the flat rate from origin (country elevator) to transit point (terminal elevator). See Figure VI

Proportional Rate - A rate charged from the transit point (terminal elevator) to ultimate market destination. Must be used with the flat rate to transit point (terminal elevator). See Figure VII & VIII

Transit or transit privilege, as the name applies, is a special or additional service, aside from the legally required service of transportation which is accorded a shipment by the railroad while it is under going transit from the origin (country elevator) to the ultimate market destination. The specific object of transit is to permit the grain to be unloaded en route (at transit point) for the purpose of storage or milling, upon paying the flat rate to the transit point, the grain or flour is reforwarded on the basis of the balance of the through rate or on the proportional rate to the ultimate market destination which ever results in the lowest through rate.

It is very important to know your freight rates to transit points (terminal elevators) and through rate to the ultimate market destinations since rates are used by you to determine your best market at any time and to set your bid to producers. If you have grain in storage at a transit point (terminal elevator) which allows you to go to various markets upon selling your grain out-of-store, you have an advantage over having grain located where only flat rates might apply on any further movements.


EXAMPLE NO. 1
WEEPING WATER, NE
.46½
flat rate
KANSAS
CITY
TRANSIT
POINT
1.20½
through rate
published single
factor rate
.74
balance of
through rate
GULF
PORTS
EXAMPLE NO. 2
LAWRENCE, KS
.30½
flat rate
KANSAS
CITY
TRANSIT
POINT
.75
proportional
rate
GULF
PORTS
KANSAS
CITY
TRANSIT
POINT
GULF
PORTS

EXAMPLES OF FREIGHT RATES

Example No. 1 - A single factor through rate of $1.20½ is published from Weeping Water, NE to the Gulf Ports. A flat rate of $.46½ is published from Weeping Water, NE to Kansas City, the transit station. Because of the transit privilege the balance of the through rate from Kansas City to the Gulf ports applies at $.74 ($1.20½ - .46½ + $.74)

Example No.2 - No single factor through rate from Lawrence, Kansas to the Gulf ports is published. The flat rate from Lawrence, Kansas of $.30½ is combined with the published proportional rate from Kansas City to the Gulf ports of $.75 to produce a combination through rate of $1.05½.

Example No. 3 - No single factor through rate is published from Milan, Missouri to the Gulf ports, nor is there a proportional rate published from Kansas City to the Gulf ports. The only through rate would be a combination of the $.42½ to Kansas City the $.84½ flat rate from Kansas City, to the Gulf ports, for a total of $1.27.

**Caution -- The rates used are not legally published rates, but are fictious rates used for the purpose of explaining rate making principles.

FIGURE I

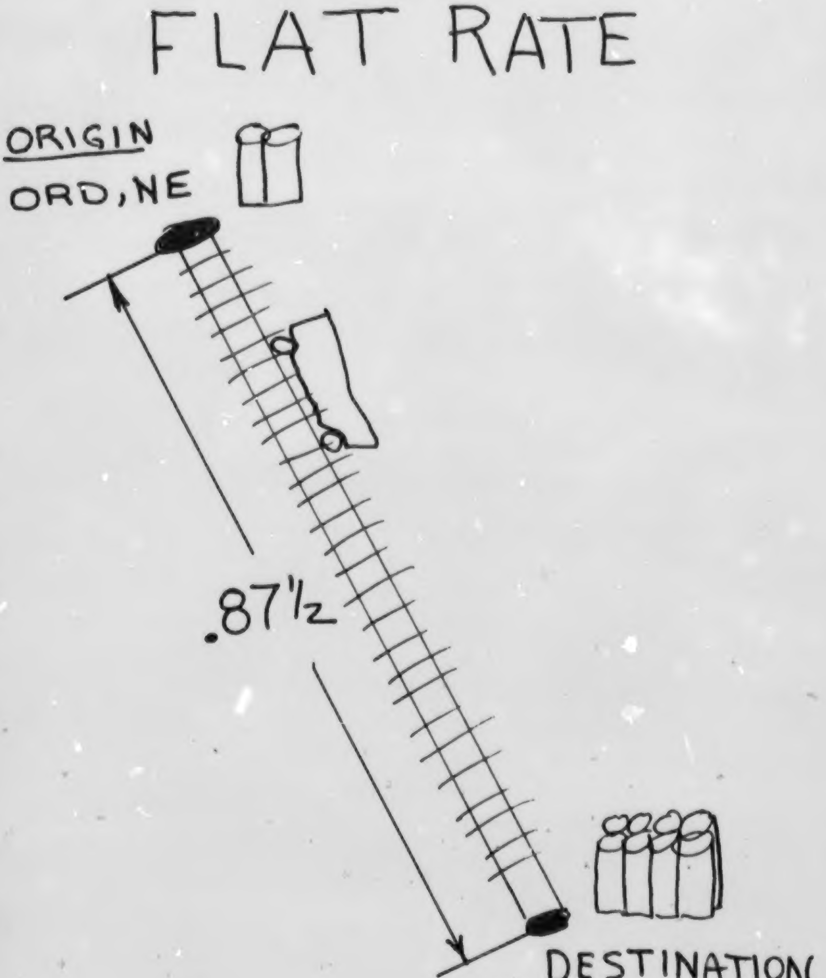

FLAT RATE
ORIGIN
ORD, NE
.87½
DESTINATION
KANSAS CITY
(TRANSIT POINT)

FIGURE II

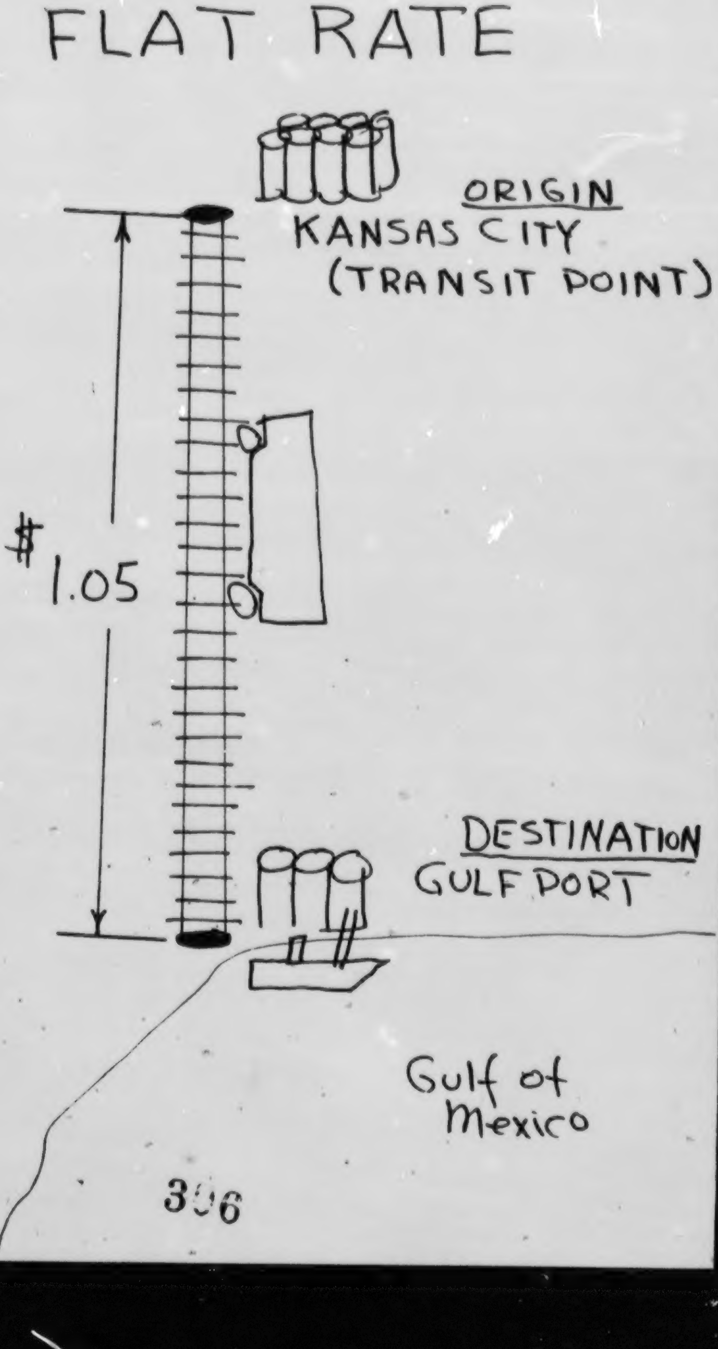

FLAT RATE
ORIGIN
KANSAS CITY
(TRANSIT POINT)
$1.05
DESTINATION
GULF PORT
Gulf of
Mexico

FIGURE III

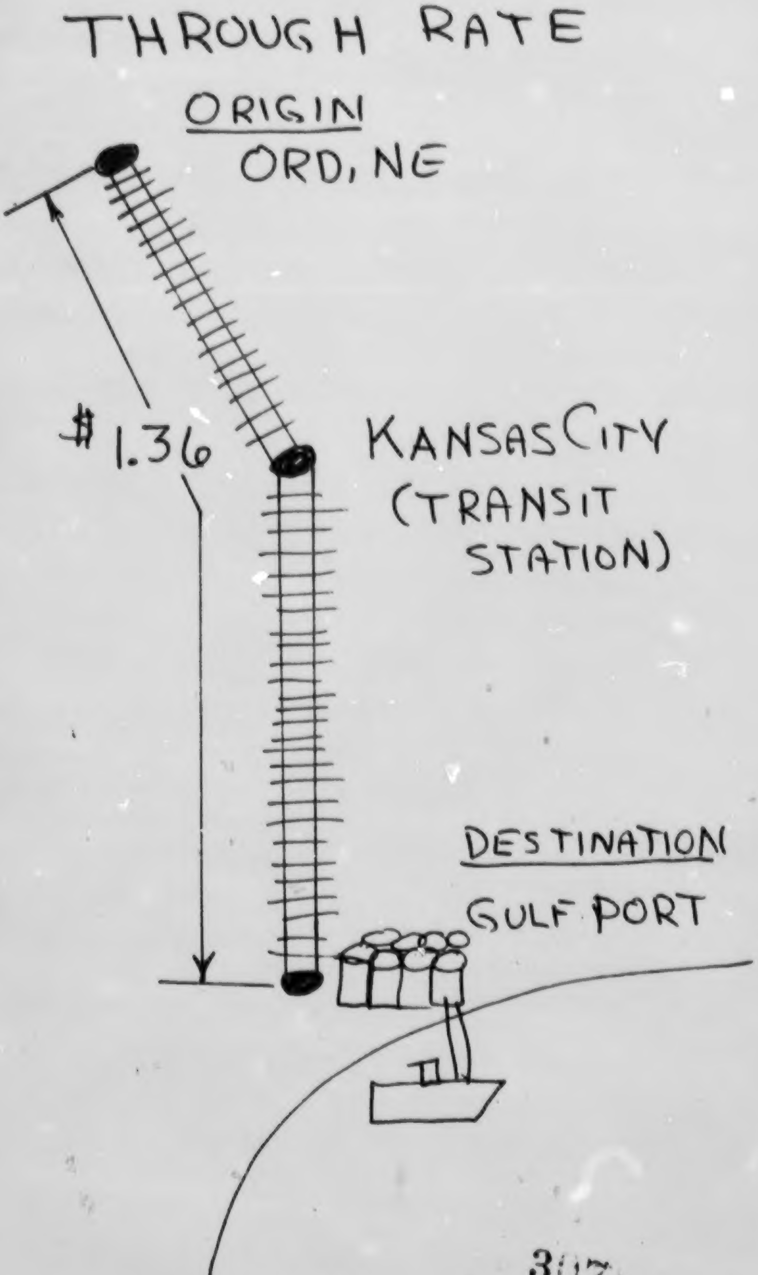

THROUGH RATE
ORIGIN
ORD, NE
$1.36
KANSAS CITY
(TRANSIT
STATION)
DESTINATION
GULF PORT

FIGURE IV

COMBINATION THROUGH RATE (TWO FLATS)

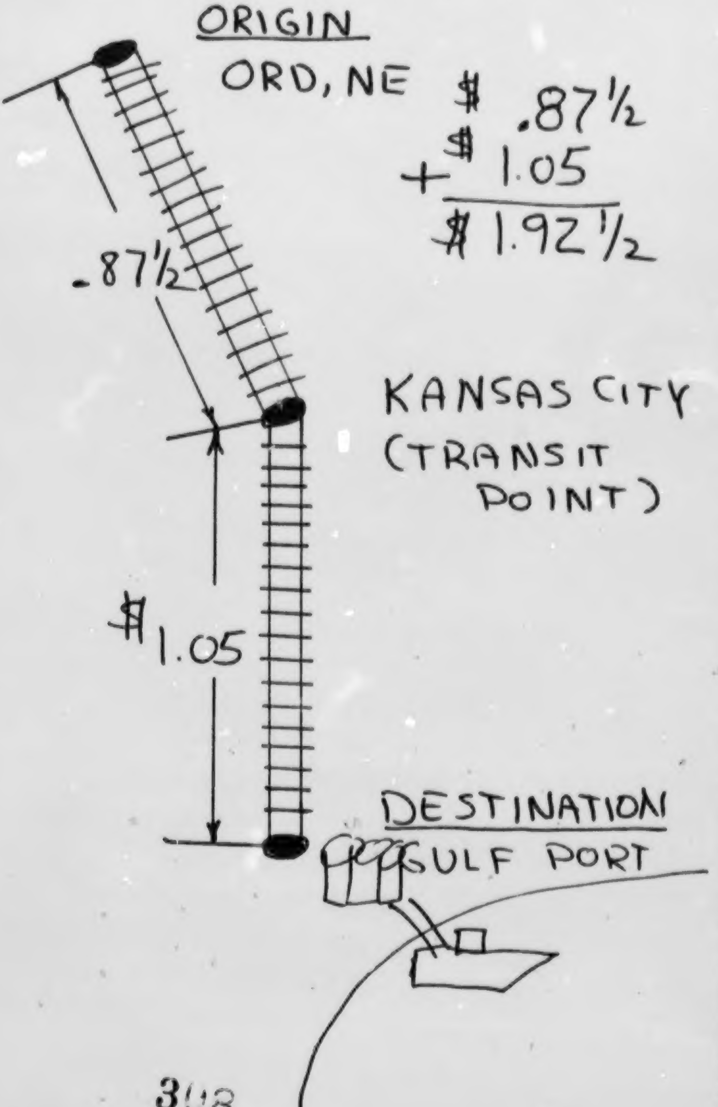

ORIGIN
ORD, NE
$ .87½
+ $ 1.05
$ 1.92½
.87½
KANSAS CITY (TRANSIT POINT)
$ 1.05
DESTINATION
GULF PORT

FIGURE V

COMBINATION THROUGH RATE (FLAT + PROPORTIONAL)

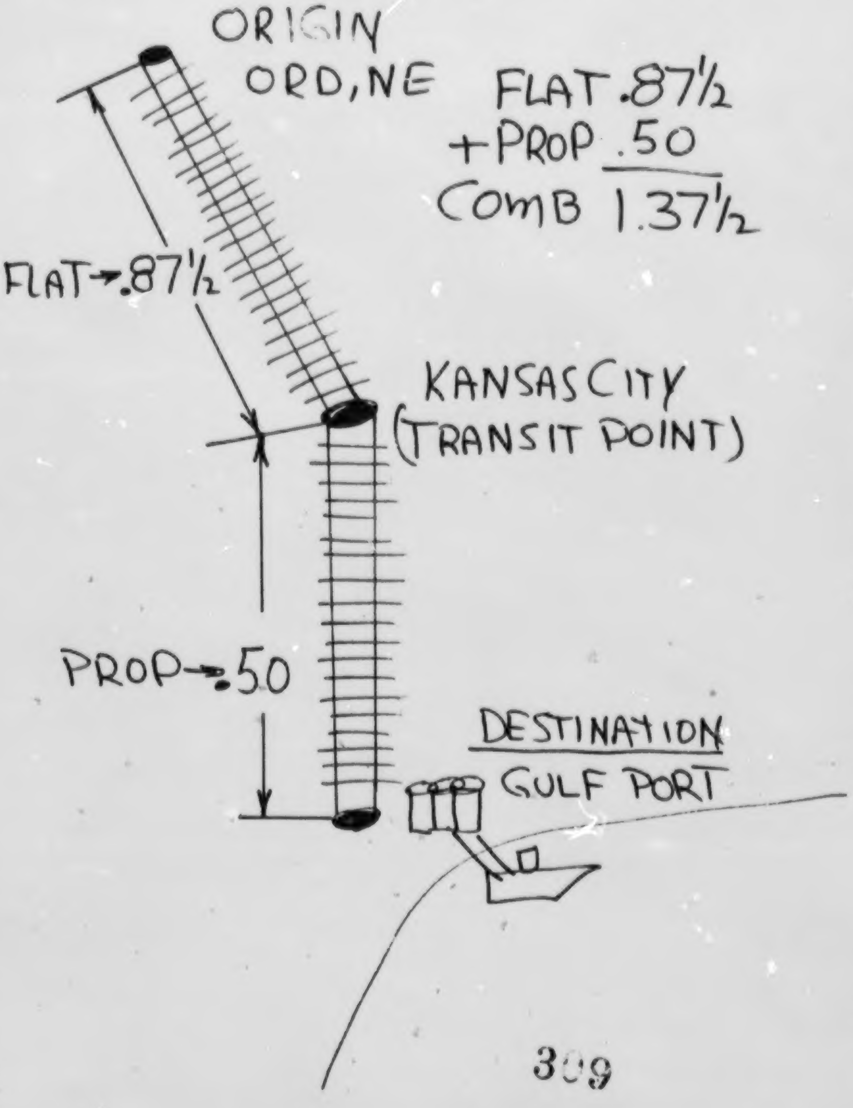

ORIGIN
ORD, NE
FLAT .87½
+PROP .50
COMB 1.37½
FLAT→.87½
KANSAS CITY
(TRANSIT POINT)
PROP→.50
DESTINATION
GULF PORT

FIGURE VI

BALANCE OF THROUGH RATE

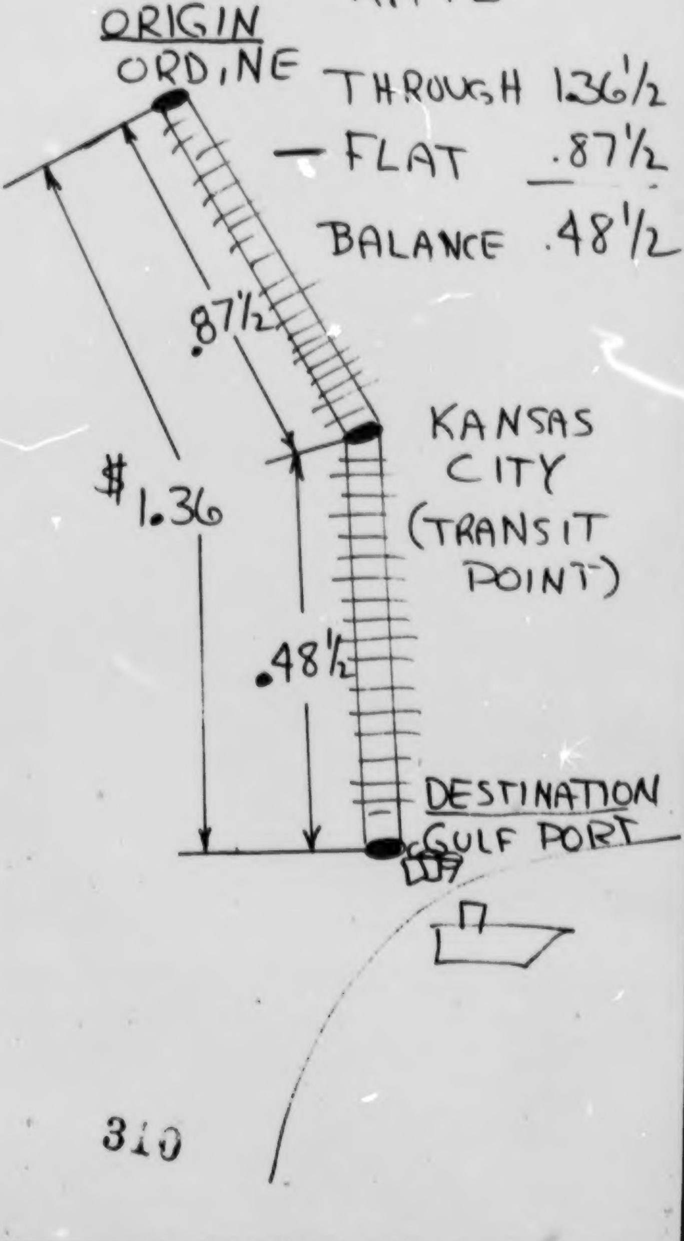

ORIGIN
ORD, NE
THROUGH 136½
— FLAT .87½
BALANCE .48½
.87½
$1.36
KANSAS CITY (TRANSIT POINT)
.48½
DESTINATION
GULF PORT

FIGURE VII

PROPORTIONAL RATE

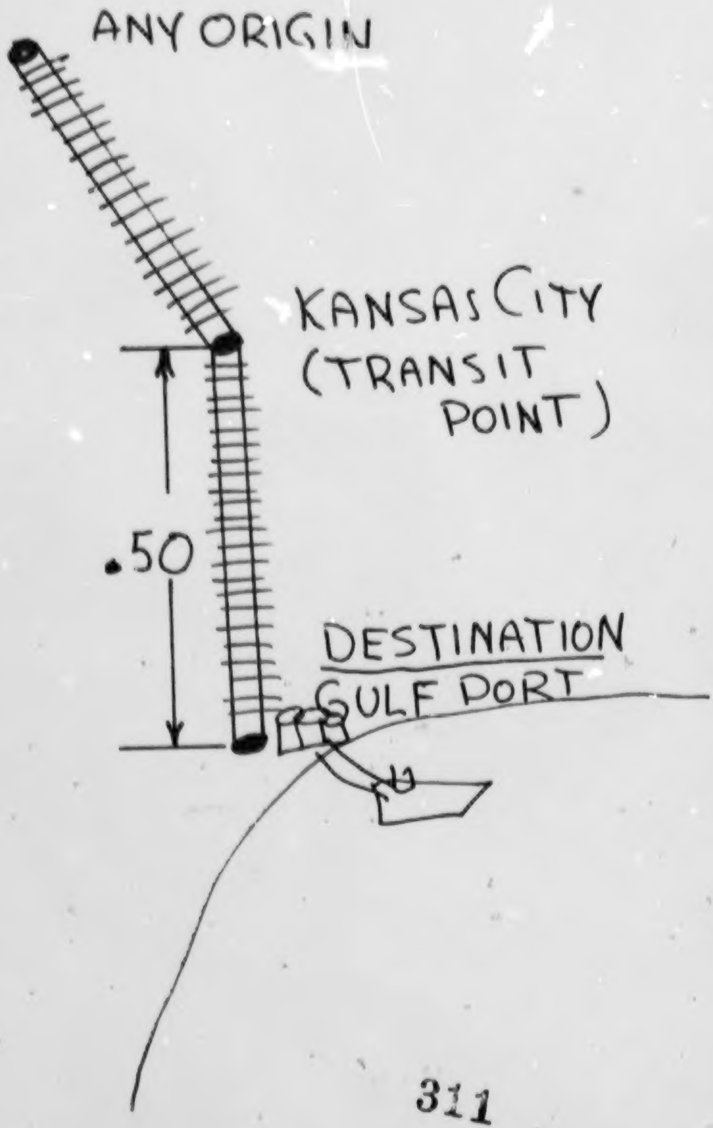

ANY ORIGIN
KANSAS CITY (TRANSIT POINT)
.50
DESTINATION
GULF PORT

FIGURE VIII

THROUGH RATE = $1.36

COMBINATION
THROUGH RATE = $1.37½
(FLAT + PROP)

COMBINATION = $192½
THROUGH RATE
(FLAT + FLAT)

PROCEDURE FOR USING TRUCK BILLS OF LADING

Below is a summary of how the information must be entered in the blank spaces on the truck bills of lading. Fill in the top half of each truck bill of lading completely.

1. DATE: Date truck is loaded
2. COMMODITY: Type of grain
3. DRAWING A DRAFT: Mark yes or no if cash grain.
4. ORGIN: Insert name of town, or sub-station, if different than main office.
5. SHIPPER: Insert name and address of your organization.
6. DELIVER TO: Insert to whom grain is delivered. Name and address.
7. LOAD OUT GRADES:
    - (a) GRADE - If applicable
    - (b) MOISTURE - Check sample for moisture
    - (c) TEST WEIGHT - Check sample for test weight
    - (d) DOCKAGE - If applicable
    - (e) PROTEIN/SPLITS - If applicable
    - (f) FOREIGN MATERIAL - If applicable
8. SALE TO: Insert the name of the company or individual to whom you sold the grain. This will be shown on the Purchase Contract mailed to you, if available at the time the sale is made.
9. SALE NO: This is the contract number of the company to whom you sold the grain. This will be shown on the Purchase contract mailed to you, if available at the time the sale is made.
10. DIVISION: Insert the name of the Division with whom you are trading.
11. SHIPPER'S SIGNATURE: For your signature

Must Be Filled Out - Self Explanatory

12. CARRIER
13. CHAUFFEUR'S LICENSE NO.
14. TRACTOR LICENSE NO.
15. TRAILER LICENSE NO.
16. DRIVER'S SIGNATURE

17. The gross, tare, and net pounds should be filled out at the time of lading.
18. LOADOUT SCALE TICKET NO: Your loadout scale ticket number
19. Please note if this is for Contract (if so show Purchase Contract No.) or for Store. The Purchase Contract No. comes directly from the Purchase Contract mailed to you.

The Bottom Half of the Truck Bill of Lading is for Official Use Only

Each copy of the truck bill of lading has a specific color and a printed label for identification directly below your loadout scale ticket no. (step 18). Ex. (Original appears below the loadout scale ticket no. on the White truck bill of loading. Duplicate on Canary Yellow, Etc.)

Distribution of Copies of Truck Bill of Lading

1. If the grain is going to any terminal elevator you must send in with the truck driver and he will leave at the elevator the Original (White), Duplication (Canary Yellow), and Buyer's (Green) copies of the completed truck bill of lading. The number in the upper right hand corner of this lading will be used for drafting and settlement purposes.
   The driver will be given two copies of the inbound scale ticket when the grain is unloaded at the terminal. He will retain the Trucker's copy and return the Shipper's copy to you for official unloading weights.

2. If the grain is going to a location other than a terminal elevator, the Original (White) and Duplicate (Canary Yellow) copies of this bill of lading must be mailed to the Division Office with whom you are trading the day the truck is loaded. The Buyer's (Green) and Trucker's (Goldenrod) copies are to be given to the truck driver and he must leave the Buyer's (Green) copy with the scale man at the place of unloading. Instruct your trucker to inform the scale man at unloading point that the number in the upper right hand corner of this bill of lading must appear on the unloading scale ticket at destination and also on settlement to the elevator.

   The Shipper's copy (Pink) is to be kept by you for your records.

   When Drawing Drafts on truck grain, the ticket no. appearing in the upper right hand corner of the truck bill of lading must be shown on the draft with prefix TT and followed by a dollar amount for each ticket.

DATE ①
COMMODITY ②
DRAWING DRAFT? ③ ☐ YES ☐ NO

Loadout Grades ⑦
GRADE (a) T.W. (c)
MOIST. (b) DOCK. (d)
PROTEIN SPLITS (e) F.M. (f)

TICKET № 209822
BUYER'S TICKET NO.

ORIGIN ④
SHIPPER ⑤
DELIVER TO ⑥

SALE TO ⑧
OR
FOR THE ACCOUNT OF
[redacted] SALE CONTRACT NO. ⑨
DIVISION ⑩
COMMENTS

SCALE WEIGHTS ⑰
LBS. GROSS
LBS. TARE
LBS. NET
DRIVER ON ☐ OFF ☐
LOADOUT SCALE TICKET NO. ⑱
ORIGINAL

(SEE INSTRUCTIONS ON REVERSE SIDE) ⑲

INSTRUCTIONS TO UNLOADING ELEVATOR
☐ SELL AT MARKET
☐ APPLY ON [redacted] PUR. CONTRACT NO.
☐ STORE
☐ PROTEIN TEST

SHIPPER'S SIGNATURE ⑪
CARRIER ⑫
CHAUFFEUR'S LICENSE NO. ⑬
TRACTOR LICENSE NO. ⑭ STATE
TRAILER LICENSE NO. ⑮ STATE
DRIVER'S SIGNATURE X ⑯

OFFICIAL USE ONLY

10 Div.	11 Br.	12 Shippers Account Number	13 Tran Code	14 Comm	17 TT	18 Truck No. 209822	21 Carrier	30 Insp Date	16 Pro No. 09822
35 Grade	36 Other Fac	37 % Dock	38 Test Wt	39 Moist	40 H. Dmg	41 T Dmg	42 F M	43 S	44 T	45 Protein-Splits	86 Car Control

APPLIED ON PURCHASE CONTRACT

Date	Number	Price	F O B	Basis	Premium	Discount	SH	CBT	Units Applied	Fd.
47	48	49	50	51 (52)	53	54	55	56	57	58
59	60	61	62	63 (64)	65	66	67	68	69	70

33 Thru Rate	83 W I P	84 Int. on Chg	85 Stg. Chg	91 Misc. Exp	Labor	92 O-side Stg Code

APPLIED ON SALES CONTRACT

100 Buyers Account Number

Date	Number	Price	F O B	Basis	Premium	Discount	CBT	Units Applied	Fd.
102	103	104	105	94 (95)	106	107	108	109	98
111	112	113	114	96 (97)	115	116	117	118	99

46 Free Stg. Store Sell	20 Draft	
126 Date Grain Unl.	162 WHR No.	
127 Gross Unl. Lbs.	128 Dockage Lbs.	
Net Unloaded Lbs.	Net Unloaded Bu.	
86 Stg. Chg.	Date Draft	Draft Amount
119 Net Sales Proc	120 Sales WIP	125 Misc. Exp.
134 Truck Paid	Date of Draft	Draft Amount
Date Truck Pd	Truck Rate	Amount

TRUCK BILL OF LADING

399

The student should fill out Figure IX a Blank Truck Bill of Lading with the following information.

1. 6-19-79
2. Wheat
3. Yes
4. Concordia, Kansas
5. Cloud County Grain Warehouse, Inc.
6. Houston Grain Exporters, Inc.
   1234 Canal Blvd.
   Houston, Texas 44400
7. U.S. #2 Hard Red Winter Wheat
   10.5% M, 62.5 t.w., .8% dockage, 12.8% protein, 1.3% F.M.
8. United Soviet Socialist Republic
9. 12,345
10. Houston Grain Exporters, Inc.
11. Your name
12. Your Grave Trucking Co., Inc.
13. 54321YOURDEAD
14. CDC 1234
15. ABC 5678
16. I.M. Steel
17. Gross 543,210, Tar 234,567
18. 2579
19. Purchase Contract

TRUCK BILL OF LADING

TICKET № 209822

BUYER'S TICKET NO.

DATE

COMMODITY

DRAWING A DRAFT? ☐ YES ☐ NO

Loadout Grades

GRADE T.W.

MOIST. DOCK.

PROTEIN SPLITS F.M.

ORIGIN

SHIPPER

DELIVER TO

SALE TO
OR
FOR THE ACCOUNT OF -

SALE CONTRACT NO

COMMENTS

DIVISION

(SEE INSTRUCTIONS ON REVERSE SIDE)

SCALE WEIGHTS

LBS. GROSS

LBS. TARE

LBS. NET

DRIVER ON ☐ OFF ☐

LOADOUT SCALE TICKET NO.

ORIGINAL

INSTRUCTIONS TO UNLOADING ELEVATOR

- ☐ SELL AT MARKET
- ☐ APPLY ON PUR. CONTRACT NO.
- ☐ STORE
- ☐ PROTEIN TEST

SHIPPER'S SIGNATURE

CARRIER

CHAUFFEUR'S LICENSE NO.

TRACTOR LICENSE NO. STATE

TRAILER LICENSE NO. STATE

DRIVER'S SIGNATURE X

OFFICIAL USE ONLY

10 Div.	11 Br.	12 Shippers Account Number	13 Tran Code	14 Comm	17 TT	18 Truck No 209822	21 Carrier	30 Insp. Date	16 Pro No. 09822

35 Grade	36 Other Fac.	37 Dock	38 Test Wt.	Mois	40 H. Dmg	41 T. Dmg	42 F. M.	43 S	44 T.	45 Protein Splits	86 Car Control

APPLIED ON PURCHASE CONTRACT

Date	Number	Price	F.O.B.	Basis	Premium	Discount	SH	CBT	Units Applied	Fil.
47	48	49	50	51 (52)	53	54		56	57	58
59	60	61	62	63 (64)	65			68		70

22 Thru Rate	83 W.I.P.	84 Int. as Chg.	85 Stg. Chg.	93 Misc. Exp	Labor	92 O'side Stg Code

APPLIED ON SALES CONTRACT

100 Buyers Account Number

Date	Number	Price	F.O.B.	Basis	Premium	Discount	CBT	Units Applied	Fil.
102	103	104	105	(95)	106	107	108	109	98
111	112	113	114	96 (97)	115	116	117	118	99

46 Free Stg. Store Sell	33 Draft	
126 Date Grain Unl.	152 WHR No	
127 Gross Unl. Lbs.	128 Dockage Lbs.	
Net Unloaded Lbs.	Net Unloaded Bu.	
85 Stg. Chg.	Date Draft Paid	Draft Amount
119 Net Sales Proc	120 Sales WIP	125 Misc. Exp.
154 Truck Paid	Date of Draft	Draft Amount
Date Truck Pd	Truck Rate	Amount

311

CHAPTER IX

GRAIN MARKETING

CHAPTER OBJECTIVES

After the completion of this chapter the student should be able to:

1. Establish a market value for grain.
2. Be familiar with techniques of marketing.
3. Be able to list factors that control market price fluctuations.
4. List the trading months for corn, soybeans and wheat.
5. Evaluate and describe a grain contract.
6. List the important features of a contract.

TEACHING AIDS

I. Films and Slides
   A. Kansas City Board of Trade - Kansas City, Missouri
   B. Chicago Board of Trade - Chicago, Illinois
   C. The Farmer has a Choice - Far-Mar-Co, Hutchinson, Kansas

II. Student Activities:
   A. Field Trip to Grain Inspection Station or Grain Exchange
   B. Field Trip to Kansas City or Chicago Board of Trade
   C. Field Trip to Commodity Brokerage office
   D. Field Trip to Terminal Elevator and Merchandising Offices
   E. Have Students Keep Track of Markets all Semester
   F. Have Students Graph all Three Commodity Markets of Corn, Wheat and Soybeans and keep one basis chart.

G. Give each student 5,000 bushels to Market during the Semester.

III. Guest Speakers

- A. Manager of Feedlot
- B. Manager of Country Elevator
- C. Manager of County ASCS Office
- D. Cash Grain Farmer
- E. Local Brokerage Office Personnel

SUPPLEMENTAL REFERENCES

1. Dr. Roy Fredericks, Kansas State University, Manhattan, Kansas.
2. "Futures Markets," Kansas State University Extension Publication.
3. "Marketing Yearbook," Heronimous.
4. "Wheat Futures Trading," Kansas City Board of Trade.
5. "Understand the Commodity Futures Markets," Goffe and Carkner, Inc.
6. "Amber Waves of Grain", James Trager.
7. "Understanding the Commodity Futures Markets," The Board of Trade, Kansas City, Missouri.

STUDENT STUDY GUIDE

The following terms and questions should be answered from the Technical and Instructional Material or Supplemental References.

At The Market -

Basis -

Basis grade -

Bear Market -

Bid -

Break -

Bull Market -

Bulge -

Buy on close -

Buy on opening -

Cash commodity -

Certified stocks -

Commission house -

Contract grades -

Cover -

Day orders -

Delivery -

Delivery month -

Delivery points -

Differentials -

Farm prices -

321

Forward shipment -

Futures -

Grades -

Hedge -

Life of delivery -

Limited order -

Liquidation -

Long -

Lot -

Margin -

Margin call -

Market order -

Nominal price -

On opening -

Open contract -

The Opening -

Opening Price -

Pit -

Point -

Position -

Premium -

Price limit -

Range -

Reaction -

Round lot -

Round turn -

Short -

Spot price -

Stop loss order -

STUDY QUESTIONS

1. List four different ways a producer can market his grain?

2. Where are delivery points or locations that a producer may deliver his grain?

3. Give an example of a cash market quotation or board price for corn, milo and wheat and list the units they are commonly marketed in.

4. What is the assumed market grade or quality for corn and wheat if only the price is given.

5. Explain (briefly) what determines the price for a bushel of corn.

6. Explain the statement "It is the law of supply and demand", as it relates to grain marketing.

7. What is the legal piece of paper issued by an elevator to a producer showing ownership of grain in storage?

8. Which branch of USDA is responsible for making government loans on grain in storage?

9. List the advantages a producer has in using a warehouse receipt.

10. Why are contracts used in grain marketing? (List at least three reasons.)

11. Give 5 primary points that should be covered in a grain contract.

12. What is the difference between a grain contract and a futures option?

13. What are the two ways commodity markets may be used? (or list for what purposes)

14. List the trading months for corn and soybeans.

15. Give 3 different locations where boards of trade are found.

16. At what times do the boards of trade open and close?

17. Answer each of the follow questions about making trades in the futures market.

    a) Who can market the actual trade?

    b) When can trades be made?

    c) Where must trades be made?

    d) How must trades be made?

18. Give the size of one grain contract and the amount of money (Manimum and Minimum) or price flucuation that is allowed.

19. Explain the two terms long and short as it relates to a) cash grain b) futures options

20. Explain and define "Basis".

21. What is the difference between a track bid and a spot bid?

22. When did the U.S. government begin trying to control production and price levels?

23. List 3 different types of contracts a grain merchandiser might use in cash marketing.

24. Draw a basis graph representing each of the following.

a) Cash grain is under the option and basis is improving

b) Cash grain is under the option and basis is widening

c) Cash grain is over the option and basis is widening

25. List and explain what Chicago corn basis has done in relation to December and July options for the last 30 days.

26. Give the dates for each of the following:

a) Beginning of St. Louis Grain Exchange.

b) Year official grain grading standards were established.

c) Agriculture Marketing Act under President Hoover.

d) The beginning of the Commodity Credit Corporation.

TECHNICAL AND INSTRUCTIONAL MATERIAL

Grain Marketing Introduction

The United States has the most developed and sophisticated marketing system ever designed. It allows the process of free enterprise to exist in harmony with government regulations and world trade. No other country in the world can produce higher quality grain and market it abroad than can the U.S. farmer. All of this is accomplished through out free and competitive market place.

America's grain marketing system is not a mystery or well kept secret, but rather a sophisticated system of supply and demand. To some it may seem far from perfect, but few marketing practices have ever existed for more than 100 years without undergoing major changes. So a near perfect system must have been designed to remain in continuous use for a full century.

There are many ways to market grain. Some methods are more accepted and understood than others. In this chapter the most basic approaches to marketing grain will be discussed briefly. For those willing to spend the time studying and charting the markets, a solid understanding of the supply and demand relationship can be obtained.

There are principally 4 methods or techniques a producer may use to market his grain crops. He may select one method or use a combination of all four methods to plan his marketing strategy. The 4 marketing techniques are (1) Cash Markets, (2) Government loans secured by warehouse receipts, (3) Contracting and (4) Using the commoditity Futures Market to hedge.

Cash Marketing

Cash marketing is the process of selling a known quantity of grain in the market place and receiving immediate payment for immediate delivery. Cash marketing may be between a producer and a livestock feeder, a producer and licenses warehouse, a producer and a processor or between one producer and another. The key issue is that a specific price per unit is determined and immediate settlement is made.

Cash marketing is the oldest form of marketing grain. During the 1800's bartering was a common practice. This was the process of exchanging one type of goods for another. The grain producer paid his bills and purchased his needs by trading a quantity of grain. As currency became a more common method of trading for goods, a bushel of grain was identified as having a specific value. Frequently grain was sold for cash (money) and the currency was then used to purchase goods and services needed by the producer. Anyone wanting a quantity of grain could buy what was needed rather than trading other raw products.

The grain producer than reached a plateau in the trade off between goods and services. He found he was producing more grain than was needed. Consequently the producer lost the ability to establish the price. When others wanted grain they indicated what they would pay rather than paying what the producer was asking. We now have the price of a bushel of grain being determined by the amount of grain available for sale. A price is established between the buyer and the seller based soley upon the availability of grain. In other words the supply and the demand establish the price of a bushel of grain.

Buyers and sellers began meeting together at regular intervals. These meeting locations became known as grain exchanges. There, sacks and bushels of grain were exchanged for money. Some of these exchanges became central markets, others became known as boards of trade. St. Louis was one of the first grain exchanges to come into existence in 1836. Trade was expanded and conducted between the fertile farm lands and the large centers of population. Buffalo, New York became such a trading center for conducting trade and selling grain in 1844.

By 1854 sufficient difficulties had arisen over buying and selling grain that a decision was made to deal in weights. Pounds and tons became the standard measure rather than bags and sacks. A large sack to one individual was not the same as a large sack to someone else. Other traders used the same sized sacks and bags but filled them to different levels with different quality of grain. Still major differences existed in trading practices to that in 1865 official grain standards were established. Official inspection and grading of all grain traded at the centers became a mandatory practice.

Freedom in the market place is the heart of our pricing structure. No one is required to sell and neither is anyone required to buy. A producer has the choice of accepting a price offered by a buyer or rejecting it. Likewise, a buyer has a choice of paying what the producer wants or not getting to buy any grain.

Price then has become the true measure of the supply and demand relationship. As supply increases or demand decreases the price per bushel declines. On the other hand, as the supply decreases or the demand increases price per bushel increases. The basic reason that grain prices do not move upward is a two fold supply problem. First, a producer somewhere is willing to accept the current price for a bushel of grain and sells into the market place. Second, producers plant a greater number of acres and grow more bushels in hopes of capturing a larger income simply because they have more bushels of grain. There in lies the paradox - more produces less, and less produces more. In other words, the more grain that is produced the less a farmer receives per bushel and vise versa.

A cash price is based on the location of the grain in relation to where it is needed. Grain located at or near its final destination is worth more than grain that is a greater distance away. Consequently, the cash price for grain is partially determined by the transportation cost.

The greater the distance away from the market, the smaller the cash price. The price of grain is then based on its location. Each of the major markets become the location basis and transportation charges are subtracted from that price. Basis Chicago means delivered in Chicago. Basis Kansas City means delivered to Kansas City. Basis Gulf means deliver to Gulf of Mexico.

Two other words sometimes used to describe a location basis is "tract" and "spot" price. What is grain worth at this spot or location. Track bids are frequently quoted to provide a local price at your elevator. The following bids indicate corn is worth the same money. The only difference is location.

a) Corn, basis Chicago - $3.00 per bushel
b) Corn, (assume 40¢ freight) - Track $2.60 per bushel
c) Corn, "spot" your elevator - $2.60 per bushel
d) Corn, FOB (delivered) feedlot - $2.64 per bushel
(Assume 4¢ per bu. trucking)

Generally speaking the words "spot", "track", "cash", and the letters "F.O.B." (free on board) are interchangeable in quoting cash prices. Sometimes "basis a location" is used as a cash price reference, but transportation pricing must be understood to adequately compare the various market bids which are quoted.

Government Loans

Guaranteed price levels for grain is relatively new in comparison to grain marketing. The first government involvement in grain programs date back to 1929. In that year President Hoover authorized a stabilization corporation under the Agriculture Marketing Act. However, it failed to stabilize prices. In 1933 Franklin Roosevelt tried a grain program under his "New Deal." In June of 1933, Roosevelt signed into law the (AAA) Agriculture Adjustment Administration. Since that time minimum price levels have been determined by various government programs.

Government loans were established to help the producers spread their marketing over a full year. The plan was to prevent mass selling by all producers during the first few weeks following harvest. However, because a producer needed finances to pay his debts he needed immediate cash. The Commodity Credit Corporation was established as part of the 1938 Agriculture Adjustment Act which begain direct crop-subsidy payments to supervise and control this process. The Commodity Credit Corporation is part of the United States Department of Agriculture.

The federal government would make a loan to the producer but needed collateral to guarantee the loan. This initiated the document known as a warehouse receipt. A warehouse receipt is issued by a licensed elevator or "grain warehouse" to the owner of the grain. This shows title of ownership.

The government then offered a second opportunity to producers. The government would guarantee or set a minimum price for the grain in each county. A loan was based on this price. At this point a producer makes a choice if he needs immediate cash. He may sell his grain for cash or he may use a warehouse receipt to secure a loan from the government. If he elects to obtain a government loan he has 11 months to redeem his warehouse receipt by paying back the loan to the government. If the loan is paid back a producer again has title to his grain and may sell it on the cash market. If the loan is not repaid, the government takes title to the grain. The warehouse receipt is forfeited by the producer in favor of a higher loan value than the cash price. In other words, the producer can not loose. He can take out a loan with a guaranteed minimum price set on the value of the grain. If grain prices go up he can pay off the loan, redeem the warehouse receipt and sell his grain at the higher price. On the other hand, if prices go lower or remain the same he does not have to repay the loan. A producer merely defaults on the loan and gives up ownership of the grain to the government at the pre-determined county loan price.

Warehouse receipts may also be used to make conventional loans at banks and are sometimes used as legal tender in purchasing machinery or paying debts.

Contracting

Contracting is becoming more and more common in grain marketing programs. A contract is nothing more than a legal document guaranteeing the performance of two or more parties in the merchandising of grain.

Contracting is frequently done to guarantee price, quantity, quality and delivery. Several variations exist however, of the basic contract.

(1) Forward Contract - In this case a producer is wanting to guarantee a price to lock in a profit and cover the cost of production. So prior to harvesting the grain, perhaps as early as planting time, a producer will "forward contract" his grain. Another example of forward contracts are with feeders and processors wanting to guarantee a supply as well as a price.

(2) Delivery Contract - This is frequently used when dealing with transportation problems. If shipment time is critical or delivery to a specific destination is important to maintain production, a delivery contract will be used.

(3) Delayed Pricing Contract - Frequently a producer anticipates grain prices going higher so he does not want to sell immediately. On the other hand he does not have adequate storage space or facilities so he must move the grain into market channels. In this case the contract passes title or ownership of the grain but delays until a later date the establishing of a price.

All contracts including the following examples have several important points identified. Note what these points are.

1. Confirmation of Purchase - The buyer of grain will provide the contract. Hence it generally is a "Purchase Contract" as opposed to a "Sales Contract".

2. Contract Number - Contracts are identified by number for filing and audit purposes.

3. Date of Contract - This is the date the contract was written and agreed upon. Any other binding dates or performance dates must be included in the contract.

4. Sellers Name and Address - Identifies the party or grain company making the sale of the grain. An authorized representative of the selling company must agree to a sign contract upon receipt from the buyer.

5. Contents of the Contract - All of the requirements of the contract are spelled out in this section. Such specifics as:

   a) Quantity and Grade quality
   b) Transportation requirements
   c) Price of the grain per unit (bushel, cwt. ton)
   d) Freight basis determines whether freight is paid by the buyer or seller (F.O.B. which location)
   e) Required shipment date
   f) Who's weights and grades will be used.

6. Billing Instructions - Any special request or agreements made for shipment and method of payment may be listed here.

7. Premiums and Discounts - All exclusions to the specific requirements are covered by paying a premium or assessing a discount. Penalties for poor performance, late shipment and low quality are generally listed. Premiums may be paid for high qualtiy, high protein content, early shipment, uniform quality or other desirable and advantageous circumstances.

8. Fine Print - Always read carefully and understand the fine print located on the contract.

9. Signature - The signature of both parties involved is generally required. However, the purchaser may provide pre-printed contracts with their company name, address, logo and printed information already contained. The sellers signature is all that would be required to make the contract binding.

CONFIRMATION OF PURCHASE —①

31462 - ②

The ABC Grain Co.
Anytown, U.S.A. 66666 - ④

4-26-79 - ③

This confirms purchase from you today by (rail)
of 190,000# No. 2 yellow grain sorghum (1 Hopper)
at $4.00 per cwt basis Track - 4-79 shipment
Hutchinson weights Hutchinson grades. - ⑤

Bill to ______________________ - ⑥

Premiums ______________________ - ⑦

Discounts 2¢ ea. wct each 1/4% over 14.0 moisture; 2¢ ea. cwt ea.
1% damage above 5; 1¢ ea. 1% FM over 8; 5¢ ea. cwt for discolor.

⑧

Cars must be loaded to capacity as required by railroad companies. Seller to pay all weighing, inspection, trackage, and interest charges if any.

Seller should always advise of shipments, stating kind of grain, probable grade, and number of bushels in each car.

When shipments are not made according to contract we reserve the right without further notice, to extend time of shipment, cancel or buy in the grain for the seller's account, unless at seller's request previous to the expiration limit of time of shipment, other arrangements are made covering sellers failure to make shipment within specified time of this contract.

We reserve the right to change destination of all shipments provided point at which weights are to be obtained is not specified above.

It is understood that this contract is not completed until all shipments are received, weighed and accepted at destination or at point or points specified above.

Unconsigned grain not applicable on this contract except by special agreement.

In all respects this contract is subject to the rules and regulations of the Hutchinson Board of Trade and receipt of this contract by the seller, without immediate notice to us of error by wire, is acknowledgement of all the conditions thereof.

The grain shipped to apply on this contract is guaranteed by the shipper to pass the Pure Food and Drug inspection until it is unloaded at final destination.

E. & O. E. By______________ - ⑨

DATE APPLIED	CAR NO.	BUSHELS	DATE A/S CHECKED	DATE APPLIED	CAR NO.	BUSHELS	DATE A/S CHECKED

SAMPLE COPY

CONFIRMATION OF PURCHASE

31465

The ABC Grain Co.
Anytown, U.S.A. 66666

4-26-79

This confirms purchase from you today by truck shipment

of 840,000# No. 2 yellow grain sorghum

at $4.00 per cwt basis Track Official weights & grades shipment

Destination weights Destination grades. Bill to

Draft for 90% of money Storage:

2¢ ea. cwt ea. 10 days starting 8-1-79 Buyer to trick

Discounts No discount to 15.0 moisture; 1¢ ea. cwt ea. 1/4% over 15.0 moisture. 8% FM allowed-1¢ ea. 1% over 8% FM

Cars must be loaded to capacity as required by railroad companies. Seller to pay all weighing, inspection, trackage, and interest charges if any.

Seller should always advise of shipments, stating kind of grain, probable grade, and number of bushels in each car.

When shipments are not made according to contract we reserve the right without further notice, to extend time of shipment, cancel or buy in the grain for the seller's account, unless at seller's request previous to the expiration limit of time of shipment, other arrangements are made covering sellers failure to make shipment within specified time of this contract.

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The grain shipped to apply on this contract is guaranteed by the shipper to pass the Pure Food and Drug inspection until it is unloaded at final destination.

E. & O. E.

By

DATE APPLIED	CAR NO.	BUSHELS	DATE A/S CHECKED	DATE APPLIED	CAR NO.	BUSHELS	DATE A/S CHECKED

SAMPLE COPY

Futures Markets

Commodity futures markets are an extension of the contracting concept. Since producers are interested in guaranteeing a price in the future they are willing to sell a "futures contract." Likewise, a food processor or grain exporting company is wanting to buy grain but at a later date. However, they too are interested in guaranteeing the price they will have to pay so they buy or purchase a contract in the future.

Two separate individuals, both wanting to guarantee a price for themselves agree to sell and buy a contract for a specific date in the future. One individual (the producer) is afraid the price will go down. The other individual (the food processor) is afraid prices may go up. So they mutually agree on a price and both have taken a position. They are hedging or guaranteeing their price.

The key points in this "futures" transaction are:

(1) There is a contract calling for specific performance by both parties.
(2) The obligated date is sometime into the future.
(3) Both parties took a hedged position.
(4) There is both a buyer and a seller involved.

Specific trading months have been designated for each grain. The calendar months remain the same year after year. Their price relationship (to each other) changes as the year progresses.

Typically option months are referred to as old crop and new crop. This reflects the harvest period of the grain in question in reference to all of the trading months. For example, corn and wheat have the following trading months referred to as trading options. March, May, July, September, December. However, for corn, December is generally referred to as "new crop" option because of the October harvest. For wheat July is referred to as the "new crop" option because of the June harvest.

Trading options received their name because a producer could exercise his choice of months to place a hedge. In other words he had an option, an either or situation. Consequently, future's months and options are interchangeable words.

As you observe the prices for each option month, note that generally the farther you advance from harvest into the futures the higher the price is on the option. This is caused by the expenses of ownership. Charges such as storage and interest make the grain more expensive in later months. This cost of ownership is generally referred to as the "carrying charges". The money it costs to own grain from one month to the next. If there is no increase in option prices the market is said to be inverted or has a negative carrying charge.

Another dimension to futures trading is understanding basis. Basis is defined as the difference between the cash price and the futures price. The basis is then explained as over or under the option price. Any option may be used to state the basis, however, the near-by option month is generally given. (Near-by means the trading month following closest to the calendar date in question. Example, October 12 has a nearby corn option of December.)

If the cash price and the option price were exactly the same the basis would be zero. Most generally the cash price is less than the option price or is "under" the option. Frequently written as a negative number. However the reverse can be true.

Under Example (1) -	#2 yellow corn	Chicago option	$2.30
	#2 yellow corn	Chicago cash	2.25
		Basis 5¢ under	-5

Over Example (2) -	#1 Hard Winter Wheat	K.C. Cash	$3.20
	#1 Hard Winter Wheat	K.C. Option	3.12
		Basis 8¢ over	+8

Basis may further be localized to a specific elevator by including transportation. The difference or basis in that case would be greater because of the freight charges. An important point to remember when figuring basis is that it represents the difference between a cash price and a futures option stated as Over (+) or under (-) the option.

The following diagrams expresses basis movement as a trend or pattern. The option price is represented as a baseline and the cash price as the graphed line. Basis is mathematically determined and plotted against the option price base line. This determines the cash basis. It makes no difference what the option price is each day. It is the cash price difference that concerns you.

Example:	Todays Futures Quote	$3.45	90 days later futures	3.54
	Todays Cash Quote	3.20	90 days later cash	3.50
		-20		-4

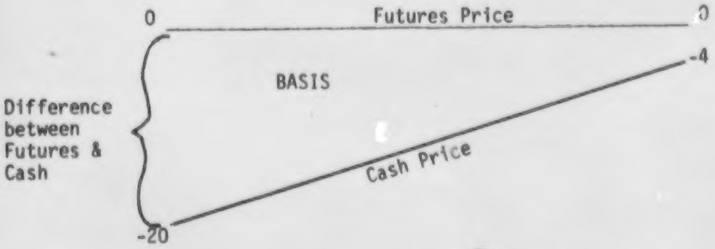
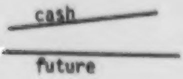
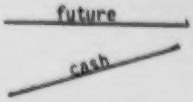
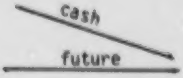
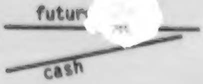
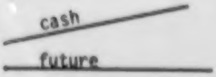
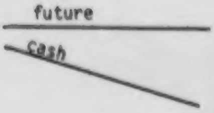
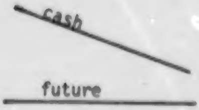
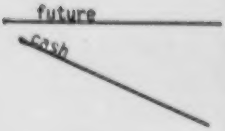


Chart Examples

Terminology	(+) cash over option	(-) cash under option
basis improvement basis is going up basis is getting better	 cash future	 future cash
basis narrowing	 cash future	
basis widening	 cash future	 future cash
falling basis deteriorated basis declining basis	 cash future	 future cash

CASH MARKETS

A. How Are They Established?
  1. Local Area Supply and Demand
    a) Livestock feeders and feedlots
    b) Good transportation such as truck backhauls
    c) Processing plants or processing mills
  2. Use of Futures or Delivery Contract Prices
    a) Subtract freight charges
    b) Subtract carrying charges of storage and interest
    c) Price created by a high demand of a specified quantity during particular period of time

B. Delivery Points
  1. County Elevator
  2. Feedlot
  3. Terminal Elevator
  4. Location Specified by Contract

C. Price Quotations by Weight
  1. Per bushel - Corn $2.24/bu.
  2. By cwt (hundred weight) - Corn $4.00/cwt.
  3. By ton - Corn $80.00/ton

D. Price Quotations By Quality
  1. By official USDA grade
    a) ie #1 wheat
    b) ie #2 yellow corn
  2. By end use
    a) ie Oil content in sunflowers
    b) ie Beer from malting barley
  3. Speciality uses
    a) Popcorn
    b) Contracted at planting for seed production
    c) Protein content in wheat for baking

E. Example Of Price Quotations
  1. Country elevator board price

Chicago cash corn - today	$2.17 per bushel
Delivery Freight to Chicago	- .27 per bushel
Track or Bid price to the elevator	1.90 per bushel
Country elevator profit	- .02 per bushel
Posted board price	$1.88 per bushel

  2. Feedlot pricing

Chicago cash corn - today	$2.17 per bushel
Delivery Freight to Chicago	- .27 per bushel
Local community track price	1.90 per bushel
Feedlot needs a supply-Premium	(+).02 per bushel
Price delivered to feedlot	$1.92 per bushel

F. Summary
  1. Emphasize grain is worth only what someone else is willing to pay for it
  2. Price will vary with the market selected such as elevator, feedlot, or processor

II. GOVERNMENT LOANS

A. Producer Elgibility
  1. Sign up at county ASCS office
  2. Set aside acres and comply with program
  3. Obtain warehouse certificate

B. Commodity Credit Corporation - C.C.C.
  1. Federal agency
  2. Provides money for loans on grain
  3. Elevator warehouse receipt is collateral
  4. Guarantees a minimum price to producer

C. Warehouse Receipt
  1. Issued by a licensed and bonded warehouse
  2. Slip of paper in duplicate shows ownership of grain
  3. A negotiable piece of paper that can transfer ownership of the grain.
  4. Matures 28th day of the 10th month after it is written
  5. May be turned over to C.C.C. through the county ASCS office for a guaranteed loan price or a lump sum loan. The warehouse receipt is then used as collateral for the loan.
  6. A producer must repay the loan to regain title to the warehouse receipt. Whoever owns and holds the warehouse receipt is the owner of the grain.

D. Advantages of a Warehouse Receipt
  1. A producer may receive a warehouse receipt immediately upon delivery of his grain to an elevator.
  2. The producer may not wish to sell the grain immediately, but needs cash to pay bills.
  3. A larger loan can be obtained by using a warehouse receipt for collateral than obtaining a loan at the bank.
  4. The producer always has the option of redeeming his warehouse receipt and then selling his grain on the open market. This is particularly important to the producer if the price of grain goes up. He now has three choices.
    a) Sell immediately for cash
    b) Use a warehouse receipt and get a guaranteed minimum loan that he can forfeit the warehouse receipt in payment of the loan.
    c) He may repay the warehouse receipt loan, reclaim the grain and sell at a higher price if grain prices increase.

III. CONTRACTING

A. A Contract or Legal Document Containing the Necessary Information Used to Market Grain.

B. Any Two Parties Agreeing to Buy and Sell Grain Should Enter into a Written Contract to Protect both Individuals.

C. Contracts May be Used to Guarantee a Price to a Producer, or it May be Used to Guarantee a Supply and a Price to a User.

- D. Most Important Parts to a Contract (Primary)
    - 1. Names of parties involved
    - 2. Amount of grain in weight or volume
    - 3. Price of grain
    - 4. Quality of the grain involved
    - 5. Date of the contract
- E. Other Important Considerations to a Contract (Secondary)
    - 1. Delivery points or locations
    - 2. Delivery dates
    - 3. Penalties and discounts
    - 4. Type of transportation to be used
    - 5. Method and time of payment
- F. Example of a Contract

IV. FUTURES MARKETS

- A. Mystery of the Futures Markets
    - 1. Created by fear of the unknown
    - 2. Used by people other than producers
    - 3. Futures contract requires delivery of a commodity in a specific stated month in the future. A paper contract.
- B. Futures Markets Uses
    - 1. Hedge - shifting the risk avoid losses
        - a) Producers and elevators
        - b) Millers and exporters
    - 2. Speculate - Assuming a risk for possible profits
        - a) Individuals
        - b) Companies
- C. Grain Futures Commodity Markets
    - 1. Chicago - corn, wheat, soybeans
    - 2. Kansas City - hard winter wheat only
    - 3. Minneapolis - soft wheat only
- D. Commodity Trading Months
    - 1. Generally referred to as options
    - 2. Wheat - July, September, December, March, May
    - 3. Soybeans - September, November, January, March, May, July, August
    - 4. Corn - December, March, May, July, September
- E. Operation of the Market
    - 1. Opening of Markets - 9:30 a.m.
    - 2. Close of Markets - 1[illegible] a.m.
- F. Trading of Futures (Options in the Pit)
    - 1. Must be done by members of the respective Board of Trade
    - 2. Must trade only during the open hours
    - 3. All trades must be made in the pit of the grain being traded
    - 4. All trades must be to buy or sell contracts
    - 5. All trades shall be done by a public out cry
    - 6. Size of a contract is 5000 bushels
    - 7. Minimum price fluctuation is 1/8 cents
    - 8. Maximum daily trading price limit is a 20 cent range with 10 cent limit up or down

G. Trading Expenses
   1. All trades require a margin deposit or guarantee generally between 15% and 20% of contract amount.
   2. Commissions are fees & trade charges for making the transaction.

V. EXAMPLE OF HEDGED POSITION

A. To be "Hedged" an Elevator Must Have an Off-Setting Position. He must be Covered or Protected from a Loss.
B. If an Elevator Buys Grain an Off-Setting Position would be to Sell a contract. If the elevator Sells grain he would Buy a contract.
C. August 1 - Examples of Placing a Hedge
   1. Elevator buys 5000 bushels of corn
      Elevator sells 1 contract of corn
   2. Elevator buys 5000 bushels of corn
      Elevator sells 5000 bushels to fredlot
   3. Feedmill sells on contract 100 tons requiring 5000 bu. corn
      Feedmill buys 1 contract of corn
D. September 1 - Examples of Removing a Hedge
   1. Elevator sells the 5000 bushels of corn
      Elevator buys back 1 contract of corn
   2. This was a perfect hedge and no further transactions are required.
   3. Feedmill buys corn to make 100 tons of feed
      Feedmill sells back k contract of corn
E. Examples Using a Price per Bushel.
   1. August 1
      Elevator buys 5000 bushels of corn at $2.30/bushel
      Elevator sells 1 contract of corn at $2.45/bushel
   2. September 1
      Elevator sells 5000 bushels of corn at $2.40/bushel
      Elevator buys 1 contract of corn at $2.55/bushel
   3. Results:

Corn			1 corn contract		
Sells	$2.40	Sept. 1	Buys	$2.55	Sept. 1
Buys	$2.30	Aug. 1	Sold	$2.45	Aug. 1
	.10	profit		.10	loss

The elevator has to get out of a hedge the opposite way he got in. Off-Setting positions must be maintained. If he sold a futures contract originally he has to buy back the same option month and the same amount of contracts when he sells the cash grain. To reamin hedged you must always maintain an equal and off-setting position in the market.

Example: If you, Buy cash grain - Sell options
                  Sell cash grain - Buy options
Example: Buy equals "Long" - Sell equals "Short"
         Long is off-setting of short

Therefore the elevator loss no money during the month he owned the grain, but he also did not grain any money either.

VI. SIX BASIC ECONOMIC FACTORS THAT INFLUENCE PRICES

- A. Supply - The Current Amount of Grain on Hand
- B. Carryover - The Amount of Grain Remaining from a Previous Harvest
- C. Demand - Combined U.S. and World Requirements of Livestock Feeders, Millers and Exporters
- D. Crop Prospects - The Upcominb Crop, Number of Acres Planted, Estimated Yield, and Weather Conditions
- E. Government Program - Price Supports, Target Prices, Release Prices and Acreage Allotments
- F. Transportation

VII. HOW DOES AN ELEVATOR MAKE MONEY

- A. By Charging for Different Services
  - 1. Storage charges
  - 2. Drying charges
  - 3. Handling and loading charges
  - 4. Blending for highest grades
- B. Basis Improvement
  - 1. Basis is the difference between the cash price for grain and the nearby futures contract price - (minus the freight charges to get it to market)
  - 2. Example:

K.C. wheat Futures Price	$3.13	
K.C. Cash Wheat Price	3.02	
K.C. Basis	.11	(under)

  - 3. Example:

K.C. cash wheat price	3.22	
K.C. nearby wheat futures price	3.16	
K.C. Basis	.06	(over)

  - 4. Basis is tenerally stated as over or under the nearby option price. So to know the cash price you must know the futures price.
  - 5. If during the time an elevator has grain hedge, the basis improves they will realize an extra profit.
    - a) For the basis to improve the difference between the cash price and the near-by option must decrease or narrow.
    - b) If the basis increases or widens during a hedged position the elevator looses money.
- C. Margins
  - 1. A margin is the money an elevator charges for its services that are above there cost of doing business.
  - 2. A margin is the immediate profit an elevator makes for buying and selling grain.
  - 3. Margins are also used as surplus money to guarantee performance in the commodity futures markets.

3. Example:

K.C. cash	$3.10
Transportation	.12
	2.98
Handling expenses	.14
	2.84
Margin	.05
Bid to farmer	2.79

VIII. SPECULATION WITH FUTURES

A. A Game of Risk, a Willingness to Take the Chance of Loosing for a Possible Big Win.

B. Speculators Keep the Market Fluid
   1. Constantly in and out of the market
   2. They are willing to take a position and risk to win
   3. May buy and sell options several times each day

C. Speculator Activities
   1. Spreader
      a) May spread between option months
      b) May spread between commodity markets
      c) May spread between different grains
   2. Scalper

      Buying and selling large volumes each day but hoping to catch 1/8 or 1/4 cents profit per bushel. A scalper is always even at the end of the day. He is never long or short in the market.
   3. Position
      a) Long - A trader has bought ("bot") an option without hedging. He has gambled that the price will go up and when he sells the option back he will make a profit. (Similar to buying a horse and hoping to sell it for more than you paid.)
      b) Short - A trader has sold an option without hedging. He is gambling that the price will go down, and when he buys the option back it will be cheaper.

         (Similar to you selling a friend a good pick-up truck. He later decides he cannot pay for the truck and sells it back to you for less money than he paid for it.)
   4. Speculator relationships
      a) Bear - Lacks confidence in the market and thinks it will decline.

         Example: "A bear would sell short hoping to buy back at a lower price."
      b) Bull - believes in the market and thinks the market will strengthen, believes prices will increase.

         Example: "A Bull would buy long hoping to sell back at a higher price."
      c) A speculator never intends to own grain. He never intends to make delivery or take delivery on any contracts. He therefore moves in and out of the market by changing his position from "bot" to sold or from sold to "bot".

D. Exercise: From the following information determine the answers to each question.

A country elevator is 65 miles from the K.C. market. The railroad has freight charges of 15 cents per bushel to haul the grain. It cost the elevator 16 cents in expenses to handle every bushel of grain and he wants to make 4 cents margin of profit on each bushel.

Today's K.C. nearby option closed at $3.37 with a basis of 11 under. A local feedlot is paying $2.89 delivered to their lot.

1. What is the K.C. cash price for grain? ____________________

2. What is the track price for the elevator? ____________________

3. Determine the board price the elevator would post for buying from the farmer. ____________________

4. Would you sell to the feedlot or the elevator?

CHAPTER X

CUSTOMER AND PUBLIC RELATIONS

CHAPTER OBJECTIVES

After the completion of this chapter the student should be able to:

1. Develop an understanding of the importance of salesmanship in agri-business.
2. Develop an understanding of the importance and techniques of making a good impression with customers.
3. Develop an understanding of the importance of appearance and attitude in salesmanship.
4. Develop an understanding of how to handle customer complaints.
5. Develop rules of conduct that he would follow when working for an agri-business firm.
6. Develop an understanding of proper telephone manners that should be used.

TEACHING AIDS

1. Have a local agri-business man come in and speak to the class on sales techniques.
2. Have students simulate different selling methods and response of customers.

STUDENT ACTIVITIES

1. Read enclosed technical material and answer the questions in the study guide.
2. Have students visit different agri-business firms and act out like they are a customer trying to buy a particular product. In class discuss the pros and cons of sales methods that was used on them.

3. Have the students complete a selling demonstration in class.

4. Have the class divide into groups and react to different customer situations.

5. Have the students discuss the selling features of some well-known product.

6. Have the students visit a complaint department and talk with the person in charge.

7. At the end of the chapter have each student fill out the "Sixty Suggested Actions to Step up Your Sales Effectiveness" which is found in the appendix.

SUPPLEMENTAL REFERENCES

1. "Personnel Management," Chruden/Sherman, 5th Edition, South-Western Publishing Co., 1976.

2. "Textbook of Salesmanship," Russell, Beach, Buskirk, 9th Edition, McGraw-Hill, 1974.

3. "Salesmanship," Kirkpatrick, Russ, 6th Edition, South-Western Publishing Co., 1976.

4. "Feed Sales and Serviceman," Agricultural Cooperative Training Agricultural Education, Teaching Materials Center, The Ohio State University, Columbus, Ohio.

5. "Personal Selling: Choice Against Chance," Mazze, West Publishing Company, 1976.

6. "Selling: A Behavioral Science Approach," Thompson, McGraw-Hill Book Co., 1966.

7. "Management of the Personal Selling Function", Goodman, Holt, Rinehart and Winston, Inc., 1971.

STUDENT STUDY GUIDE

The following terms and questions should be answered from either the Technical and Instructional Material or Supplemental References.

Customer -

Salesmanship -

Need -

Feature -

Benefits -

Retail Selling -

Industrial Selling -

Wholesale Selling -

STUDY QUESTIONS

1. Who is the customer?

2. List and describe the three kinds of customers.

   a.

   b.

   c.

3. People are interested primarily in ________________.

4. Every kind of customer will use the word ________________.

5. Are the women who enter your business important? Explain.

6. When is the most important time that a customer spends in your business?

7. Two out of three customers are lost from a farm store because of a salesman's ________________.

8. It takes ________ muscles to smile and ________ muscles to frown.

9. When selling a small product it is a good idea to let the customer ________________ the product.

10. When showing a customer a line of products, be sure and how your ________________ products first.

11. The "__________, __________, __________, __________, and __________" questions give you an opportunity to demonstrate interest seeing that the product is right for the customer.

12. Explain this statement - Customers don't buy products.

13. List and describe three ways to describe products when selling.

    a.

    b.

    c.

14. Less than _______ out of _______ salesmen care enough about their customers to try to show them what the product will do for them.

15. Explain - Customers judge a man's ability by the way he looks.

16. How is attitude part of your appearance?

17. Define customer relations.

18. Who should make final decisions on customer complaints? Why?

19. Under Rules of Conduct, discuss each area as it would relate to you and your job in an agri-business firm.

    a. Conduct -

b. Reporting to Work -

c. Absence -

d. Alcohol -

e. Smoking -

f. Horseplay -

g. Religion/Politics/Race -

h. Make use of spare time -

i. Loafers -

20. Always answer the telephone __________ in a ________ __________ manner.

21. _____________ forget to return a call.

22. Match the stages of the sale (right-hand column) to their explanation (left-hand column) and place the correct number in the blank provided.

______ a. Prospect takes action to satisfy the need

______ b. Prospect becomes convinced that a particular product or course of action will satisfy the need

______ c. Prospect wants to do something that will satisfy the need

______ d. Prospect becomes interested in doing something about that need

______ e. Prospect becomes aware of a need

1. Desire stage
2. Attention stage
3. Action stage
4. Interest stage
5. Conviction stage

23. List three phases of a good sales presentation.

a.

b.

c.

24. Select basic types of selling by placing an "X" in the appropriate blanks.

______ a. Retail

______ b. High pressure

______ c. Industrial

______ d. Wholesale

______ e. Discount

25. Select the basic buying decisions of a customer by placing an "X" in the appropriate blanks.

______ a. How much should I pay?

______ b. When should I buy?

______ c. Why should I buy?

______ d. Where should I buy?

______ e. What type, brand or style should I buy?

______ f. How much should I buy?

26. Select the basic traits of a successful salesperson by placing an "X" in the appropraite blanks.

______ a. Good looks

______ b. Enthusiasm

______ c. Poise

______ d. Nice car

______ e. Leadership

______ f. Reliability

______ g. Loyalty

______ h. Selfishness

______ i. Perseverance

______ j. Self-centered

______ k. Honesty

27. Match the five basic steps (right column) to their explanation (left column) by placing the correct number in the blank provided.

______ a. Welcoming or meeting the customer.

______ b. Determining the customer's needs.

______ c. Demonstrating the merchandise.

______ d. Overcoming sales resistance

______ e. Closing the sale

1. Talking points
2. Demonstration
3. Approach
4. Closing
5. Related items, product benefits and substitutions

28. List eight duties of a salesperson.

a.

b.

c.

d.

e.

f.

g.

h.

29. Distinguish between the do's and don'ts of closing a sale by filling in the blanks with either "Do" or "Don't."

a. ____________ display a friendly manner at the close, even though there is disagreement between the customer and the salesman.

b. ____________ be sure to have all materials and equipment that will be needed.

c. ____________ let the customer know how much the sale means.

d. ____________ realize that begging for a sale makes the salesman and his product look bad--it also disgusts the customer.

e. ____________ be apologetic, particularly in quoting price.

f. ____________ make written or oral promises unless authorized to do so; otherwise there will be friction and expense.

g. ____________ ask the customer to "OK" or approve the order rather than sign it.

h. ____________ make a ceremony out of closing.

i. ____________ make buying as easy and painless as possible.

j. ____________ give the customer an excuse or an opportunity to back away from the purchase.

k. ____________ ever ask the customer for the buying decision in such a way that he can answer with a "Yes" or a "No," for the latter closes the door.

l. ______________ try for privacy at the close.

m. ______________ study each customer as a baseball pitcher studies each batter.

n. ______________ make it difficult for the customer to complete his purchase quickly if he cares to do so.

TECHNICAL AND INSTRUCTIONAL MATERIAL

All business activity should be directed a customer relations. Your farm store or elevator is a business offering special services and products just as other business firms are offering the same things. Your activities are directed at matching or surpassing your competition in your bid for the customer's patronage. The following material should help you in assisting the customer and having a more effective public relations for the business.

Who is the Customer?

The people who visit the local farm store or elevator often fall into three braod categories. Maybe you've noticed them.

THE DECIDED CUSTOMER - he knows what he wants, he finds it himself, pays for it and leaves with it.

THE BROWSER - he often says, "Oh, I'm just looking," and he often is doing just that without any idea of what he wants to buy.

THE UNDECIDED CUSTOMER - he knows he needs a certain product, but he's not quite sure which one.

Just about any employee in the farm store can handle the decided customer. Just be pleasant and take their money without making them wait too long. The looker is not difficult to handle because often he or she can entertain himself if something is suggested to look at. Often, it's the undecided customer that requires some of your time and attention. Remember, most customers coming into the store are in a buying mood, but that doesn't mean they will buy. It takes your help and skill for them to make a decision. Before you can help your customer make a decision, you need to understand what motivates him to buy.

People are interested primarily in themselves. Think about it a minute. Just about everything we do is related to our own self interests. Customers buy only if purchasing is in their best interest. It is helpful to imagine every customer with a sign on his forehead that says, "So what". He is really not interested in how the product is made or where it came from. What he is really interested in is what it will do for him.

Every kind of customer you meet in the store will use the word "need," but the word has different meanings for different purchases. For example, one customer might say, "I need some gasoline," as he pushes his car into the filling station. Another customer might say, "I need some paint for my living room," when she has become tired of the old color Each of these "needs" are important to the customers but they mean very different things.

As a professional salesman in the store, if you listen carefully you will hear the customer saying things that tell you what his real need is. His need may be physical (he doesn't want to walk the rest of the way to town), it may be pride (she may want her friends and neighbors to make nice comments about her living room) or it may be for several other reasons. The important thing is to listen to the customer and ask questions to find out what he wants the product to do. Remember, we said most customers are not interested in how the product is made or where it came from; as they are only interested in what it will do for them.

Not only do customers come in three basic types, they also come in just about all sizes and price ranges. Sometimes we think of the customer is the farmer-member of the business. But, of course, many times the customer in that farm store will be a youngster. You'll find young shoppers in the store who fall into the "decided," "browser" and "undecided" categories. Don't overlook how important these young people are. Someday many of them will be farmers and ranchers in the same community and will remember the courtesy they received when they went to the farm store or elevator.

Many of the customers who come to your store will be retired farmers or older people who once again fit into the three basic categories. Of course, don't overlook one of the most important customers to enter the store - the wife of the farmer member. Often she comes to the store to pickup products needed for the farm or to pay bills, and her opinion of the service received there becomes very important in the decision she and her husband must make about where to buy the products they need.

The customer you see today may be buying only a dollar's worth of nails. If treated properly however, he may return some day for a ton of feed. Regardless of how much the customer spends in the store, how old he is or how much influence he has in the operation of the business, his purchase is important to him. He wants your help in showing him how the products will solve the "need" he has.

Greeting the Customer

The first ten seconds the customer is in the store can often be more important than the next ten minutes. A simple but honest and friendly greeting to the customer as he enters the store can often do more to set the stage for sales than any other single thing you might do in a sales presentation. Making the customer feel welcome is not a complicated thing to do.

Some people think that a "good salesman" must run across the store, grab the customer's hand, slap him on the back, tell him how fine he looks and ask him how things have been going. That may seem silly to you and you probably wouldn't do all of those things, but it is surprising how many people feel that the "glad hand routine" is a way to make customers feel welcome. Of course, you wouldn't want to be treated that way as you entered a store in your community. What both you and your customers want is simply to be treated as a good friend. Isn't it nice to feel that you are more important than whatever the clerk may have been doing before you entered the store? Your customer may not require much assistance, but he surely does like to feel that someone knows that he has entered the store. Every customer likes to feel like a somebody. No one likes to be ignored and overlooked - treated like a nobody. Following is a chart that gives some of the major reasons why people stop buying at the local farm store.

Why you Loose Customers

68% drift away because of your indifference

14% have unadjusted complaints

9% want lower prices

5% trade with friends

3% move away

1% die

It's a little bit scary but more than two out of three customers who decide to quit buying at the local farm store do so because the employees didn't seem to care whether they came into the store or not. When they entered the store, no one spoke to them, smiled or made them feel important.

When you make someone feel important, you are establishing rapport. As your lists indicate, rapport can be established by doing something as simple as saying, "Hello," or "Hi there." It always helps to include a friendly attitude, a nice smile, or kind word. Establishing rapport can include making comments about the day or the appearance of the person. Statements like:

"Gee, isn't it a nice day?"

"Really wet out there, isn't it?"

(Commenting about the child) "What a pretty dress she has. Gosh she has pretty eyes."

People like to be noticed and to receive friendly comments before the sales interview begins.

A smile is such an important part of a friendly greeting. It takes only 17 muscles to smile, but more than 62 to frown. In other words, it really takes an effort not to smile. A friendly smile is a quiet way of saying, "It's nice to see you." or "I'm looking forward to visiting with you" or, "I'm feeling good today." Some salesmen can say the nicest words, but without a smile they sometimes don't have the same meaning to the customer. You might say, "How may I help you today?" But if you don't have a smile on your face, the customer may feel that you really don't want to help him and the only reason you're asking is because you have to.

Isn't it nice to go into stores where you are known? It's nice to have salespeople recognize you and smile at you. When you are a customer, you like to be called by name. Your customers enjoy the same kinds of things. Your customers are really no different than you; as they like to be treated like an old friend, someone who is important.

After establishing rapport, it is best to get down to business by asking a question that helps you find out why the customer came to your store. The best kind of question to ask is one which cannot be answered "Yes" or "No." For example, "How may I be of help to you today?" is not only a friendly question but it also helps you find out some information about the customer's visit to the store. Often salesmen ask defeating questions like:

"Can I help you?"

"Something for you?"

"Do you need anything?"

"What do you want?"

"Can I sell you something?"

"What's your problem today?"

"What can I do you out of?"

Some customers could hear that kind of question and interpret it, "Why did I come to the store?" They might feel that you want to get rid of them as quickly as possible and get back to whatever task you are working on before they so rudely interrupted you. One of the most common questions asked by a salesman is "May I help you?" Even this question can imply "May I help you so that I can get back to my work?" It also has another problem, it can be answered "yes" or "no." If the customer answers it this way, you really haven't learned anything that will help you serve him better.

For the customer who is already in the store and has begun to look at a specific product, a different approach might be to comment about the product. Suppose that you walked up to a customer who was looking at a radial tire and wanted to use this different kind of approach. Instead of saying, "How may I help you?" you might say "The tire you're looking at is the strongest, most reliable tire in our line." You might also offer the customer the opportunity to look at other merchandise, for example, "Be sure and take a look at the batteries we have on sale when you finish looking at the tires."

Offering the customer an opportunity to look at something instead of just "looking" is especially important for the browser.

Most good salesmen enjoy smiling and making the customer feel welcome so much that they don't ever consider it work. A funny thing happens when we get friendly. It's a lot like smiling in a mirror. The more we smile at customers, the more they smile back. I'm sure in the time that you have worked for the farm store you've seen those situations when a farmer comes in and asks to see a specific employee. Even though many people offer to help him, he likes that certain employee so well that he ends up saying, "I'll come back when ________ is here." Many times some of the salesman's best friends will be the customers that he seen almost daily in the farm store.

Salesmanship

When a customer comes to your store looking for a specific product, the very best thing you can do is show it to him. This sounds simple but we sometimes forget how important it is to let the customer see what he has just asked for. So when a "decided" customer comes to your store, after you have greeted him, take him to the product that he asked to see.

The other two kinds of customers, "the browser" and the "undecided," are the ones that will need help. Seeing the product will have a great impact on their willingness to buy. This is why television has had such a tremendous impact on sales. People see products on television and then when they get to the store and see the same product again, they remember most of the things that were said on the TV commercial. When you are talking to a customer about a product which is small enough for him to hold, be sure and hand the product to him. A good sales technique is to take two of the products - one for him and one for you. You'll find it is surprising how often the customer will keep the product. When the customer has the product in his hand and is looking at it, his attention is totally dominated and he won't be easily distracted by other things going on in the store. If the product is too big or not in stock at your store, be sure to use a brochure or catalog that has a picture when you are describing the products so that the customer can envision how it looks. The image of that product will be stored in his mind much better, along with the words that you say about the product, than if you simply talk about it.

Many people who do on-the-farm selling work have talked about situations in which they visited the farmer and made some notes for him about a feeding or fertilization program on the back of an envelope. Interestingly, when the farmer comes to the farm store even a week or two later with the envelope, he can remember most of the things the salesman said by looking at those figures and explaining them to the counterman. Whenever you are calculating or designing a special use of your product for the customer, be sure to use your pencil. Write down how much of the product he needs, when he should use it and the names of the product, etc. All of these things will help him remember your presentation.

When you're handling merchandise, handle it with respect. Doing this makes the product seem more valuable, more important in the eyes of the customer. He will tend to see it as being a more valuable product and when you hand it to him, he will probably handle it with respect as well. Handling products with care also demonstrates to the farmer-owner that you are taking good care of the merchandise that he already partially owns.

When you show a customer your products, be sure to show him your best quality products first. Of course when a customer arrives at the store knowing exactly what product he needs or wants, take him to the product he asks for. But when he's not completely certain, show him the best quality before showing him the lower priced items. Not every customer wants lowest price. Every one likes to buy high quality merchandise. No one ever gets mad at a salesman for suggesting that the customer consider buying a higher quality item. No customer should ever have to say to you, "Well, I'd like to see something a little higher quality if you have it."

Show him all the things that the best quality product in your line will do, explain to him the value before showing him the less expensive products in the line. It's easy to sell down to a lower priced product. In fact, some customers feel like they have saved money by buying your next best quality rather than the top-of-the line. As the customer begins to indicate his needs or spending limitations, you should begin to focus on the product that is right for him. Eliminate the other products from your discussion and if possible, put the product that best fits his needs into his hands. Reduce the number of choices the customer must make. Help him focus on the one product that is right for him.

One of the best ways to find out what the customer really wants is to ask him questions - where will the product be used - when does he need it - who will be using it - why is he interested in this particular one - what does he want the product to do - how does he want to buy it. The "what, why, when, where, who and how" questions give you an opportunity to demonstrate interest in seeing that the product is right for the customer. It also gives you the information you need to help the customer make a decision.

Show and tell selling is easy because you don't have to do much telling. When you are showing a customer a product, handling it as though it were important, allowing the customer to hold it, you really don't have to do much fancy talking. You'll also help the customer remember far more about your product. When you're showing and telling, you're not "selling" you're really just helping the customer find out the things he needs to know about your products.

Benefit Selling

When you talk about your products, make it easy for your customer to buy them by describing them in terms that he understands. Following is a little poem describing the reaction many customers have to long winded presentations by a salesman who is not talking in terms they understand.

I see that you've spend quite a big wad of dough
To tell me the things you think I should know.
How your store is so big, so fine, and so strong:
And your record of service goes back oh! so long
So the store started in 1902.

How interesting that is--especially to you.
(You're building the thing up with the blood of your life?)
I'll run home like mad, tell that to my wife!
Your appliances are modern and oh! so complete:
Your manager is flawless: your people so neat.

Your motto is quality with a capital "Q"--
I wonder why I'm tired of hearing about "You."

So tell me quick and tell me true
(Or else, my love, the heck with you!)
Less: "How this item came to be;"
More: "What the darn thing does for me?"

Customers don't buy products. They buy what the product will do for them. No farmer really enjoys buying oil, but he does buy oil - when he understands what it does for him. It helps his tractor run smoothly, saves him money on repair bills or other things important to him. Customers like to hear about products with programs in terms of what the products or programs mean to them personally. The mistake many salesmen make is assuming that the customer can see what the product will do for him. They assume that the customer can figure out the benefit. Often this business of assuming leaves many questions in the mind of the customer and makes it very difficult for him to make a decision. Products can usually be described in three ways. You can describe the features, the functions, or benefits. Let's define these three ways to describe products.

A feature is anything that describes how the product is made, packaged, or put together. For every feature there is a function. The function tells what the feature does. For example, if you were describing a radial tire, there are reasons for every feature of that tire to exist. The steel belts in the tire are there to provide greater carcass strength and puncture resistance. Both of these are functions of the steel belts of the tire. Some people wonder why functions should even be discussed. Salesmen have said, "Why not explain the feature of the product and the benefit and skip that function stuff." Let's suppose you were describing a fertilizer product which had 20% nitrogen. Skip describing the function and construct a sentence which says something like, "This product contains 20% nitrogen, which means higher yield and more earnings from your farming operation." Now, you may understand how 20% nitrogen produces higher yield, but the customer may not understand at all. By omitting that middle element, the function, when you describe why 20% nitrogen does what it does, you leave the customer with many questions. You may also leave the customer with the feeling that you have just glossed over the issue or perhaps are only saying things you know he wants to hear. Functions, then, provide a natural bridge between explaining how the product is constructed and how it will benefit the customer.

Benefits help the customers visualize the product being used by himself. Benefits help him see that the product does something for him. Most important, benefits help convert the product from an impersonal manufactured object to a needed and useful item. Features and functions are very easy to recognize. Anybody who looks at the product can normally pick out several features to describe. Benefits on the other hand, have to be personalized to the specific customer. As you are visitng with the customer and asking questions, you will learn wny he might be interested in such things as a can of oil, a new wrench, fertilizer or whatever. He may talk about saving money or increasing crop production on his farm or many other things. These are clues to what he wants to find out about your product.

When you describe your products in terms of benefits, you are showing your customer your sincere interest in seeing that the product is right for him. Probably the single most important question in the mind of the customer is "What's in it for me?" Benefit selling normally answers these questions and reduces the number of objections the customer raises. When you describe your products in terms of benefits, you eliminate many of the "so-what's" in the mind of the customer.

Less than one out of seven salesmen care enough about their customers to try to show them what the product will do for them. This is why in the minds of many customers "all refrigerators are pretty much alike" or "a tire is a tire." It simply means that all the other guys who have visited with him about tires have not taken the time to show him how the product will perform for him. If you'll take the time, you'll not only make a more favorable impression on the customer, but you'll probably make the sale.

General Selling

The four stages of a sale are as follows: Attention stage - Prospect becomes aware of a need; Interest stage - Prospect becomes interested in doing something about the need; Desire stage - Prospect wants to do something that will satisfy the need; Conviction stage - Prospect becomes convinced that a particular product or course of action will satisfy the need; Action stage - Prospect takes action to satisfy the need. In other words, buys the product or service.

The phases of a good sales presentation are approach, demonstration, and close.

There are three basic types of selling, retail, industrial and wholesale.

There are several basic buying decisions that a customer must ask himself before purchasing a product. Some of these are as follows: Why should I buy; What type, brand or style should I buy; Where should I buy; How much should I buy; When should I buy.

The successful salesperson should possess most of the following traits. These traits are confidence, perseverance, comprehensiveness, reliability, tact, loyalty, enthusiasm, leadership, conversational ability, oral expression, poise, grooming, honesty.

The basic steps in selling any product are as follows:

1. Approach - Welcoming or meeting the customer.

2. Talking points - Determining the customer's needs.

3. Demonstration - Demonstrating the merchandise.

4. Related items, product benefits and substitution - Overcoming sales resistance.

5. Closing - Closing the sale.

The general duties of a salesperson include prospecting, conducting sales interviews, closing sales, servicing, following-up, handling complaints, administering credit programs, performing other duties common to all employees.

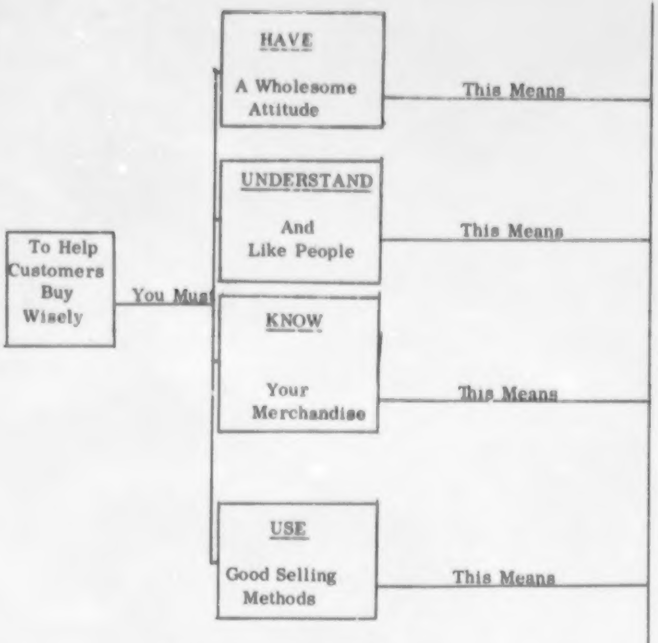
Here are some do's and don'ts of closing a sale.

1. Do display a friendly manner at the close, even though there is disagreement between the customer and the salesperson.

2. Do be sure to have all materials and equipment that will be needed. (Note: Misplaced order blanks, obsolete price lists, and dry fountain pens can lose sales.)

TABLE I

FUNDAMENTALS FOR SUCCESSFUL SELLING


To Help Customers Buy Wisely
You Must
HAVE
A Wholesome Attitude
This Means
UNDERSTAND
And Like People
This Means
KNOW
Your Merchandise
This Means
USE
Good Selling Methods
This Means

1. Keep your personal appearance neat & attractive.
2. Keep enthusiastic about your job
3. Watch your health.
4. Be helpful to your customers
5. Be loyal to your store.

1. Get your customers point of view.
2. Serve people as you like to be served.
3. Be courteous, considerate, and attentive.
4. Be friendly, but not familiar.
5. Find out what your customer wants.
6. Treat customers as invited guests.

1. Know what your store carries in stock
2. Know the location of each item carried
3. Know the facts about the merchandise you sell.
    a. Facts about material.
    b. Facts about construction.
    c. Special features and qualities.
    d. How to care for and use the merchandise.
    e. Store's own brands.

1. Meet customers promptly and courteously.
2. Present your merchandise with respect and appreciation.
3. Give honest convincing facts about your merchandise.
4. Answer questions and objections fully - help your customers decide.

(Courtesy of Fairchild Publishing Company)

3. Do realize that begging for a sale makes the salesman and product look bad - it also disgusts the customer.

4. Do ask the customer to "OK" or approve the order rather than sign it.

5. Do make buying as easy and painless as possible.

6. Do try for privacy at the close. (Note: Phone calls and third parties distract.)

7. Do study each customer as a baseball pitcher studies each batter. (Note: Then pitch to his weakness.)

8. Don't let the customer know how much the sale means.

9. Don't be apologetic, particularly in quoting prices.

10. Don't make written or oral promises unless authorized to do so; otherwise there will be friction and expense.

11. Don't make a ceremony out of closing.

12. Don't give the customer an excuse or an opportunity to back away from the purchase.

13. Don't ever ask the customer for the buying decision in such a way that he can answer with a "Yes" or a "No," for the latter closes the door.

14. Don't make it difficult for the customer to complete his purchase quickly, if he cares to do so.

Refer to Table I for a complete outline of the fundamentals for successful selling.

Appearance

What the customer sees while looking at you makes him believe what the rest of the business is like.

So you see, you are the most effective form of advertising that the business has. Your appearance is telling the customer through advertising, to trade; or in some cases not to trade here. That's why it's important to always look presentable. Your hair should be neat and trimmed at all times. We realize that today's style is for longer hair, but we do not want shoulder length hair. We believe that a man can be in style without having excessively long hair.

Wearing a complete uniform at all times suggests to the customer that this business offers professional quality services. It implies that here is a well organized operation of highly trained personnel.

How then, just being in a uniform is not enough. The uniform should be clean and well kept at all times. This is so important that in some cases uniforms might have to be changed more than once a day. Wearing a shop coat while doing dirty jobs could help solve this problem.

Customers judge a man's ability by the way he looks. If they like his appearance, they will have more confidence in the things he sells.

Remember:

1. Wear full uniform
2. Hair neatly trimmed
3. Face clean shaven
4. Hands and nails clean
5. Wear a smile
6. Be friendly and polite

Attitude

Another part of your appearance is your attitude. If you show lots of teeth, as we say, then that warm friendly smile will reflect an attitude to the customer that is pleasing to him. He will think that you are a nice guy and that is essential to making a sale. Have you ever thought of why the man is coming to your business just now? The chances are, he needs a product or service that you can offer. In other words, he has a problem and he looks upon you as experts who can solve his problem for him. Therefore, to capitalize on this, your attitude should be an extreme desire to be helpful. This is what he wants, so make sure he gets that impression from you by what you say and do. Pleasant enthusiastic spoken words accompanied by a warm friendly smile will go a long way to create that impression you want. To paraphrase an old expression: If you want to be helpful, then act helpful.

Customer Relations

Customer relations means getting along with people. Courtesy is essential. The customer is really your guest. Prepare for him as if company were coming and then treat him as if he were your rich uncle.

Complaints

Occasionally complaints will occur, even in the well organized business. All complaints should be taken seriously no matter how minor they may appear to you. At the time, they are important to the customer or he wouldn't have mentioned it. A complaint handled properly can turn into a sales opportunity. Here are some suggestions:

1. Listen attentively without interruption. Let him get if off his chest.
2. Ask questions, and get all the facts.
3. Be sympathetic and agreeable.
4. Don't argue.
5. Don't try to answer or give a solution until you have all the facts.
6. Refer the customer to the dealer if he is present.
7. If the dealer is absent, inform the customer that the dealer will contact him.
8. Follow up with your boss to make sure the complaint has been handled. These things have a way of being tabled which is very irritating to a customer.
9. Your function is to soothe the rumpled feelings of the customer. Let your boss make the final decision.
10. Don't make any promises you can't keep.

Most complaints, if handled promptly, can be settled with ease once you separate the irritation from the facts. Delay only increases the irritation. Ask your boss if he agrees that a good policy would be to guarantee satisfaction.

Rules of Conduct

Conduct - In addition to the points of appearance and attitude, here are some rules of conduct that the good salesman follows:

Reporting for work - Reports in uniform, ready, to work, on time. Arrives early enough to see what jobs are in progress and which must be done first. Considers the man going off duty.

Absence - Call if you cannot report to work because of illness or any other reason. Schedules may then be adjusted and another person put on duty.

Alcohol - Do not report to work with alcohol on your breath. There must be no drinking while on duty.

Smoking - Confine smoking to the office and to the times when you are not dealing with a customer.

Horse play - Everyone likes a joke or some horse play, but a place of business is not the place for it. Customers resent it, and some don't come back.

Religion/Politics/Race - One of a salesman's skills is making a good impression upon all customers. Nothing makes people more angry than disagreement upon these three subjects. He doesn't let himself be drawn into discussions about them. Don't ARGUE with the customer on ANY subject.

Make use of spare time - An elevator or farm store is a place of business. When not waiting on customers, use your time to an advantage by cleaning up, arranging stock, setting up displays or cleaning equipment. Do not read magazines, books, or newspapers while on duty. If you have time to loaf, you are not necessary to the operation of the business.

Loafers - The "No Loafing" rule should always be applied with tack and good judgement. Loafers are a deterant to business and should be told to leave if necessary.

Telephone Manners

Always answer the telephone promptly and in a courteous friendly manner, as every caller may be a customer. Identify the place of business and yourself.

"Concordia Elevator, Bill speaking."

A harsh "Hello" sounds both cold and unbusinesslike.

2. If the person called is not in, always offer to take a message. Write it down. Be sure you have all the pertinent information including the exact telephone number and the name of the person calling. Never trust this to memory. Then be sure the message is delivered. Always offer to help the caller. By doing this, it may be that the information can be provided. If not, it can help to expedite the answer when the customer is called back.

3. When a question is asked that cannot be answered right then, explain this to the customer. Then get the information and call him back. Never forget to return a call.

4. The telephone in your elevator or farm store is a business telephone and personal calls should be held to an absolute minimum. There is nothing more frustrating to a customer than a business telephone that is always busy.

SIXTY SUGGESTED ACTIONS
TO STEP UP YOUR SALES EFFECTIVENESS

The sixty suggested actions to improve sales effectiveness can be helpful to you. Think of each point in terms of several recent calls. Then honestly rate yourself on that point. Make notes of what you need to do to improve that action in your sales presentations. Make a list of the topics on which you feel you can improve. Then practice improving these points.

ACTIONS WHICH MIGHT HELP YOU!

Be a Believer

1. Do you believe in selling as a career? (not just a way to make a living) ______Yes ______ No

Study the autobiographies of outstanding salesmen and find out what made or makes them tick. You will find study of these autobiographies extremely rewarding.

Visit the final user of your product and find out what benefit or benefits are being derived from the use of your produce or service.
______Often ______ Seldom

Find out how many other employees in your company are dependent upon your selling efforts. (Very often as many as thirty or more non-selling people are supported by one salesman.)

Look on yourself as a deliverer of an important part of the American Standard of Living. Remember, products and services are only worth something when they are consumed.

2. Do you believe in your product? ______ Yes ______Mostly ______Some

Learn at least a minimum of three major selling points (not just product features) for each product in your product line. If you don't have too big a line, you will find it helpful to learn at least three reasons why a prospect needs your product, three reasons why your product fits the need, three reasons why your product is a better buy than those sold by competitors, and three reasons why the prospect should buy now rather than later.

Study competitive products, policies, procedures, and sales strategies, but don't mention your competitor's name unless the buyer does. Use this information to build up your own products but not to knock competitive products. ______ Often ______ Seldom

Read trade journals which carry information pertaining to your products or related products. ______ Regularly ______ Sometimes ______ Never

Study all company literature concerning your products.
______ Always ______ Sometimes

Test your own products or obtain performance results from others and you will be more thoroughly sold on what you sell. _____ Yes _____ No

3. Do you believe in your company policies and procedures?
______ All ______ Most _____ Some

Sell your company policies and procedures as well as yourself and your products. Particularly sell the "why" behind company policies.
______ Yes ______ No

If you feel policies or procedures should be changed, don't gripe to fellow salesmen or buyers; tell your superiors about your constructive ideas. ______ Yes ______ No

4. Believe in your superiors

Try to prove them right rather than wrong.
______ Always ______ Sometimes ____ Never

Try to see management's viewpoint.
______ Always ______ Sometimes ______ Never

Help your superiors to do a better job and you will both win in the end.

What your Health

5. Visit a doctor periodically - There is a realtionship between your health and your attitude and finally your effectives as a salesman.
______ Yes ______ No

6. Eat, Sleep and Relax in such a manner as to keep yourself in good physical condition. ______ Yes ______ No

7. Don't talk to buyers about your aches and pains; they usually are not interested. ______ Yes ______ No

8. Dress to fit the occasion - Don't be overdressed or underdressed.
______ Yes ______ No

9. Do you watch items of clothing such as diamond stick pins or bow ties that may lead some buyers to feel you have superior attitude?
______ Yes ______ No

10. Do you wear fraternal pins and rings? They may assist in establishing relations with some customers but then lose you a chance to do business with others. ______ Yes ______ No

11. Your automobile is part of your appearance. Do you keep it clean and presentable? ______ Yes ______ No

Be Sincere

12. Check what you say for validity. ______ Yes ______ No

13. Learn what you need to know and don't bluff. If you don't know - say so, but offer to find out. ______ Yes ______ No

14. Obtain proof to make the unbelievable believable to a buyer. However, too much evidence may be self-defeating.
______ Yes ______ No

15. Don't make promises which your management will not or cannot back up. However, you may have to take some calculated risks.
______ Yes ______ No

Plan Your Work: Work Your Plan

16. Plan your work in advance for each trip, each full day, and each call.
______ Yes ______ Sometimes ______ No

17. Make appointments in advance or at least let regular buyers know you are coming, if possible.
______ Yes ______ Sometimes ______ No

18. Use your waiting time to improve yourself.
______ Yes ______ Sometimes ______ No

Study literature on your product or products, your industry, your customers and selling techniques.

Plan future calls, make out reports and/or proposals, and (if you haven't done it previously) decide on the objective of the sales interview coming up and specifically how you are going to accomplish it.

19. Keep in account of how you spend your day for a period of a month.
______ Sometimes ______ Never

Such analysis may suggest to you means by which you can spend more face-to-face time with customers and prospects.

Set up a work pattern for yourself and then evaluate your actual performance against your work pattern.
______ Sometimes ______ Never

Be Organized

20. Find out in advance as much as you can about a prospect and his business before making a call.
_____ Always ____ Sometimes _____ Seldom

21. Don't take more time than necessary to complete an interview in a businesslike manner.
______ Seldom ______ Usually

22. Evaluate the number of calls made and/or time spent on each account or type of accounts relative to realizable, potential sales.
______ Continually ______ Occasionally

23. Keep your sales aids organized for use during sales presentations.
______ Always _____ Sometimes _____Seldom

24. Perform your non-selling duties during hours and/or days which are lease valuable for face-to-face contact.
______ Always _____ Sometimes _____Seldom

25. Set up objectives yourself such as:

Increasing or decreasing the number of calls you make. ____ Yes ___ No

Increasing your number of accounts through consistent prospecting.
_____Yes ____No

Setting up a specific number of displays. _____Yes ____No

Making a certain number of demonstrations. _____Yes ____No

Increase the number of products in your product line you sell each account.
_____Yes ____No

26. Have your automobile checked periodically to prevent loss of selling time resulting from automotive breakdowns that could have been avoided.
______ Always ______ Seldom

Keep Learning

27. Study all bulletins and literature carefully.
______ Always ______ Seldom

28. Use analogies to explain product information more quickly.

______Always ______ Sometimes ______ Seldom

29. Translate product features into talking points which will appeal to a buyer. ______Always ______ Sometimes ______ Seldom

Improve Your Sales Interviews

30. Present your sales proposition with the right amount of pressure to obtain a decision. Avoid high pressure - The art of good selling lies in the concealment thereof in all techniques used.
______ Yes ______ No

31. Avoid indifference - Show an interest in the problems of the buyer. Individualize your sales presentation for every buyer on every call.
______Always ______ Sometimes ______ Seldom

32. Learn to listen to a prospect with your eyes as well as your ears.
______ Yes ______ No

33. Empathize but Don't Sympathize by letting the prospect know you understand his viewpoint. However, remember, don't become so enamored with his viewpoint that you don't try to influence the prospect to make a buying decision. ______ Yes ______ No

34. Use reaction selling - Make it easy for buyers to buy by listening to and sharing with your prospect his problems.
_____ Yes _____ No

35. Concentrate on situational selling techniques - Develop alternative ways of handling recurring situations.
_____ Yes _____ No

36. Specific recommendations for improving sales interviews.

Opening Remarks

State who you are, who you represent and what you have to offer of interest to a prospect or buyer. _____ Yes _____ No

Don't spend too much time on your company in your first few minutes with a prospect unless such information is requested.
_____ Yes _____ No

Use some strong, attention-getting remark showing you have something of interest for the prospect. _____ Always _____ Seldom _____ Sometime

If you must go through a receptionist, treat her with respect.
_____ Always _____ Sometimes

Telling Your Sales Story

Listen to what the buyer has to say so you can sell him what you have to offer in terms of what will expedite his buying decision.
_____ Always _____ Seldom _____ Sometimes

Use questions to control the interview.
_____ Always _____ Seldom _____ Sometimes

Speak slowly and distinctly enough for a prospect to comprehend what you are saying. _____ Always _____ Seldom _____ Sometimes

Make your sales presentation a two-way conversation moving from generalities into specifics. _____ Always _____ Seldom _____ Sometimes

Eliminate weak connection words and phrases such as: See! This here! Ah's, Er's and Yeak's! In other words, Ect."
_____ Never _____ Sometimes _____ Frequently

Use implied complements such as: "You are the first to ask a question of that nature". _____ Never _____ Sometimes _____ Frequently

Demonstrating

Carry samples with you when they are small enough or, if not, scale models or some part of the larger product.
_____ Always _____ Sometimes _____ Rarely

Don't just "tell and sell" but also "show and tell".
_____ Always _____ Sometimes _____ Rarely

Keep your sales aids up-to-date and in presentable condition.
_____ Excellent _____ Fair _____ Poor

Have the prospect participate in a demonstration when and if possible.
_____ Yes _____ No

Quoting Prices

Build up the value of your product before quoting a price.
_____ Always _____ Sometimes _____ Rarely

Quote price correctly. _____ Yes _____ No

Don't just quote a price but always submit a profit statement on product investment in terms of percentage on sales, stock turnover, and dollars invested in inventory; or picture to the user the benefit or enjoyment to be gained.
_____ Always _____ Sometimes _____ Seldom

Meeting Competition

Keep alive to inroads made on your accounts by competitive salesmen.
_____ Yes _____ No

Don't be afraid of competition - but don't ignore it.
_____ Yes _____ No

Learn what competitive salesmen are saying to accounts.
_____ Yes _____ No

Know the advantages and disadvantages of competitive products and merchandising plans. _____ Most _____ Some _____ Few

Answering Objections

Use a question; possible just a simple "Why" may be effective in some instances.
_____ Yes _____ No

Repeat the objection but not in a sarcastic tone.
_____ Yes _____ No

Use "yes but" technique, but not the phrase. _____ Yes _____ No

Offset an objection with a number of plus factors on the other side of the ledger.
_____ Yes _____ No

Let the prospect "blow off" steam and the objection may be wiped out through the prospect's own logic. _____ Yes _____ No

Isolate the chief reason for not buying and then proceed to answer it. _____ Yes _____ No

Closing

Ask for the order in a number of ways and a number of times, if necessary, to get the order. _____ Always _____ Sometimes

Don't settle for token orders. _____ Yes _____ No

Assume the prospect is going to buy. _____ Yes _____ No

Close on a summary of all your major points discussed in an interview. _____ Always _____ Sometimes _____ Seldom

Follow-up

Thank the customer for his time, his order, or his cooperation _____ Yes _____ No

Don't forget to give a little attention to employees other than the buyer in an establishment. Win the good will of not only the buyers and salesmen, but also of countermen and delivery men. _____ Always _____ Sometimes _____ Seldom

Never show disappointment or dismay if you fail to get an order, but prepare the way for another call. _____ Yes _____ No

Reconstruct each sales interview trying to figure out what you did well and might want to use again, and what you did which needs to be changed or perfected. _____ Always _____ Sometimes _____ Seldom

37. Remember to Give your prospects a chance to think about and to act upon what they see and hear from you. _____ Yes _____ No

38. See in your prospect what the prospect would like for others to see in him. _____ Yes _____ No

39. Change the level of your sales presentation to fit the mentality and knowledge level of each prospect. _____ Yes _____ No

40. Arrange your sales presentations under circumstances in which there is little probability of being interrupted, if possible. _____ Yes _____ No

Be Positive

41. Maintain a positive attitude but avoid arguments. _____ Yes _____ No

42. Avoid negative statements such as "You don't want to buy anything today, do you?" _____ Yes _____ No

43. Wipe out continued worries - They have no place in sales efforts; they are like rocking in a rocking chair - you put forth so much effort which gets you no place. _____ Yes _____ No

Assist a Prospect To Buy

44. Provide your buyers with merchandising plans, advertising ideas, and sales promotional gimmicks, or to the ultimate user instructions on the use of your product or services. _____ Always _____ Sometimes _____ Seldom

45. Relate to your buyers what other users, distributors, jobbers, and dealers, have been successfully doing to sell more at a greater profit. _____ Yes _____ No

46. Assist your dealers by training their sales people to sell your products or users to use your products more effectively for greater satisfaction and/or profit. _____ Always _____ Sometimes _____Seldom

47. Handle complaints promptly and judiciously. _____ Yes _____ No

48. Assist your buyers with problems such as forecasting sales, pricing of products, inventory control, securing profitable lines, getting and holding satisfied customers, recruiting, training, and supervising salesmen, expense control, layout of establishment, and other managerial techniques. _____ Yes _____ No

49. Keep your buyers informed on the news in the trade. _____ Yes _____ No

Get Others to Assist You

50. Cooperate with your credit, service, advertising, engineering, and merchandising departments. _____ Always _____ Sometimes _____ Seldom

51. Merchandise company advertising and promotional schemes. _____ Yes _____ No

52. Call on your superiors for their help when you need it. _____ Yes _____ No

53. Get your accounts to assist you in selling other accounts. _____ Yes _____ No

54. Record your practice sales presentations on a tape recorder. _____ Yes _____ No

Self-Improvement Will Pay Off

55. Write out new sales presentations on a new product or merchandising plan in a simple and conversational style.
______ Always ______ Sometimes ______ Never

56. Eliminate from your presentation irritating phrases, cliches which have lost their sales punch by being overworked. ______Yes ______No

57. Ask some close friend to tell you about any recurring, annoying mannerisms that are limiting your selling success. ______Yes ______No

58. Read at least one article a month and one book a year on selling
______Yes ______No

59. Talk to other salesmen about sales strategies they have found successful. ______Frequently ______ Rarely

60. Avoid gossiping about your own personal affairs, internal company matters, or information given you in confidence by other buyers or salesmen. ______Yes ______No

Be A Star Salesman

Remember - every star salesman has made mistakes, but he doesn't make them often. The star salesman not only learns from his experience but also from the experience of others.

Salesmanship, like everything else, is the result of hard work and self-sacrifice in order to learn to do the job in the best possible way. Start now to improve yourself and thereby make your sales soar throughout the Soaring Sixties. Climb the ladder of sales success by outselling competitive salesmen and you will become and remain a star salesman.

APPENDIX

I. Student Self-Instruction Exercises
    A. Stored grain insects

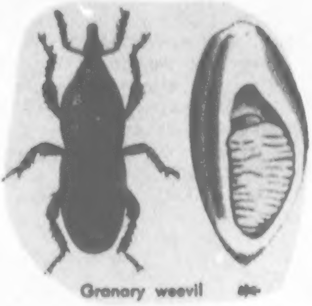
II. Occupational Experience Training Plan
    A. General farm supply and elevator employee

STUDENT SELF-INSTRUCTION EXERCISES

STORED GRAIN INSECTS

GRANARY WEEVIL

Importance and Type of Injury


Granary weevil

This true weevil is one of the most destructive grain insects in the world. They cause almost complete destruction of grain in elevators, in farmers' bins, or on ships where conditions are favorable to their growth and the grain is undisturbed for some length of time. Infested grain will usually be found to be heating at the surface, and it may be damp some times to such an extent that sprouting occurs. Many small beetles, with distinct snouts projecting from their heads, will be working over and in the grain. The kernels of grain are eaten and contain small, legless, fat-bodied, white grubs feeding on the inside.

Food

Wheat, corn, macaroni, oats, barley, sorghum, kaffir seed, wheat, and other grain and grain products. Adults feed upon whole seed of flours, but the larvae develop only in seeds or pieces of seeds of cereal products large enough for them to live within and not in flours unless they have become caked.

Distribution

The granary weevil is probably not native to North America. It is distributed all over the world in shipments of grain. The granary weevil is less prevalent, at least in tropical and semi-tropical climates.

Life History, Appearance, and Habits

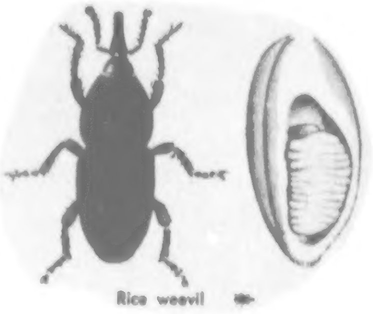
In unheated storages winter may be passed as larvae or adults, the latter stage surviving zero weather for several hours. The adult granary weevil is a somewhat cylindrical beetle, about 1/6 inch in length. It is dark brown or nearly black in color, with ridged wing-covers, and a prolonged snout extending downward from the front of the head for a distance of about one-fourth and the length of the body. The rice weevil has much the same general appearance, although it is somewhat smaller. There is usually a patch of somewhat lighter, yellowish color on the front and back of each wing cover. A distinguishing mark is in the shape of the small shallow pits on the prothorax of the beetles: in the rice weevil these are round, in the granary weevil they are oval. The wing covers are somewhat grown together and are unable to fly.

The female weevil chews slight cavities in the kernels of grain or in other foods and there deposits from 300 to 400 small white eggs, one in a cavity, sealing it in with a plug of gluey secretion. The eggs hatch in a few days into soft, white, legless, fleshy grubs which feed on the interior of the grain, hollowing it out; on becoming full-grown, they are about 1/8 inch in length. They change to naked white pupae and later emerge as adult beetles. The entire life cycle may be passed under favorable conditions in from 4 to 7 weeks. Adults can withstand starvation for 2 or 3 weeks, often live 7 or 8 months, and may survive for over 2 years. In Kansas there are from four to five generations of the insect each season. In unheated storages, both larvae and adults can survive over winter.

RICE WEEVIL

Importance

Along with the granary weevil, the rice weevil make up the two most destructive insect pests of stored grain. It attacks whole healthy kernels of grain, eating out the inside, until only the hull remains. Weevil damage to grain is also serious from a contamination standpoint, because cleaning the grain does not remove those insects hidden inside the kernels. The rice weevil is a native of India.



Rice weevil

Description

Adults

Overwinters in the adult or larva stage.

Reddish-brown to almost black.

Has a prominent snout.

Not over 3/16 of an inch in length, slightly smaller than the granary weevil.

Has four yellow to red spots on its wings.

It has wings so it can fly as contrary to the granary weevil.

It has round shallow pits on the prothorax.

Eggs

The female weevils deposit their eggs in holes they chew in grain kernels; they seal the hole shut with a gelatinous material after the egg is laid.

Female adult weevil may lay from 50 to 400 eggs during her lifetime.

Eggs hatch inside the grain.

Larvae

The larvae are small, white and legless.

They devour the inside of the grain until they are full grown.

A larva can only develop in a kernel of grain that is large enough for it to live in.

Pupae

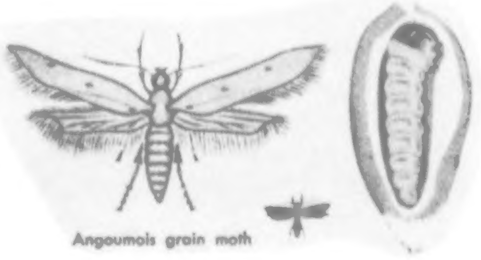
When larvae are full grown they pupate inside the grain. After pupation they emerge from the grain cavity as adults.

The entire life span of weevils requires about four weeks in warm weather. During cooler weather of autumn and spring a longer time is required.

ANGOUMOIS GRAIN MOTH

Importance

This is the most common of the moth insects that attack stored grains. The larvae attacks grain in storage as well as in fields. Most of the damage done by this insect is done to stored grains.



Angoumois grain moth

Type of Injury

Grain in bins or ear corn in storage has small buff moths flying about the bins or crawling rapidly over the surface of the grain when it is disturbed. One or two small round holes are eaten in the kernels of infested corn, or in other grain. This insect is the most destructive grain moth occurring in this country. It is extremely important in the South, causing great damage to corn in cribs and also destroying ripening grain, especially wheat, in the field.

In unheated buildings, there are probably two generations a year in the latitude of Kansas and central Illinois. In the warmer parts of the South, as many as six generations occur annually. The insect is killed by cold winter weather, but in heated buildings, such as storehouses or mills, breeding is continuous throughout the year.

Description

Adults

This delicate moth is buff or yellowish brown in color.

It has a wing span of about 1/2 to 2/3 of an inch.

The hind wings are uniformly light gray, with heavy fringe of hairs which are longer than the width of the wing membrane. The wing membrane is prolonged at the apical angle like a thumb or finger, this easily distinguishes it from clothes moths.

This is the only observed stage of the life cycle. The moths emerge in the spring and lay their eggs on stored grains or heads of small grains in the field.

Eggs

They are almost microscopic in size and are either laid singly or in a cluster of as many as 20.

The number of eggs laid may vary from 40 to 400.

The eggs are white when first laid, but later change to a reddish color.

Where the moths are working out-of-doors, the eggs are attached to wheat heads in the field or to the grain in the shock. They hatch in from 4 days to 4 weeks, and the worm-like larvae at once burrows into kernels of grain.

Larvae

When the larvae hatch they crawl to a grain kernel and often spin a cocoon, which assits them in boring into hard kernels.

After the larva enters the kernel it feeds on the inside until fully grown. It then prepares an exit hole in the kernel hull, which has a flaplike lid.

The full grown larva is about 1/5 an inch long, white in color, with a yellowish head. Six true legs, and four pairs of prolegs. This stage normally lasts from 20-24 days but it may lie dormant over winter.

Pupae

A silken cocoon is spun and the larva changes to a dark red pupa.

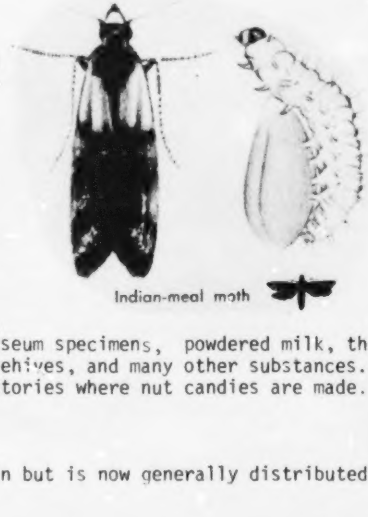
After the pupae stage, the adult moth emerges, pushing its way through the flaplike opening.

The life span from egg to adult can be completed in five weeks. Development is longer in cooler weather.

INDIAN MEAL MOTH

Importance and Type of Injury

This is one of the most general and troublesome of the moths infesting stored products. Infested material will be more or less webbed together and often fouled with dirty silken masses containing the excreta of the larvae.



Indian-meal moth

Food

This insect attacks all kinds of grains, meal, breakfast foods, soybeans, dried fruits, nuts, seeds, dried roots, herbs, dead insects, museum specimens, powdered milk, the excrement, exuviae, and pollen in beehives, and many other substances. It is frequently a pest in candy factories where nut candies are made.

Distribution

The insect is of European origin but is now generally distributed throughout the United States.

Description

Adult

This moth is approximately 5/16 in. long with its wings at rest, and has a tip to tip wing span of 1/2 to 3/4 in. When at rest, the wings are folded closely together along the line of the body and the antennae are flat on the wings. The front of the forewings is a grayish-white color and the tip half or two-thirds, as well as the head and thorax, are a contrasting reddish-brown. The underwings are grayish white.

Eggs

Female lays 40 to 350 white to gray eggs singly or in clusters on the larval food or adjacent objects. The eggs hatch in from 2 days to 3 weeks into small caterpillars, the larvae stage.

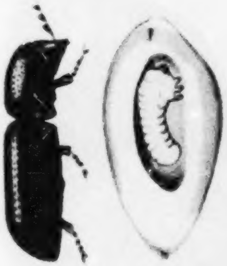
Larvae

Full grown larvae are about 1/2 in. long, dirty white, varying sometimes to greenish and pinkish tinged. They have a light brown head, prothoraic shield and anal plate. As the larva reach full growth they spin silken webs and these webs may cover the entire surface of stored grains. Many of the kernels will be found webbed together with the silken threads. It devours grain embryo or germ.

Pupae

Upon becoming full grown the caterpillars crawl up to the surface of the food material and pupate in a thin silken cocoon, from which the adult moth emerges in 4 to 30 days. The entire life cycle of the moth will usually require from 4 to 6 weeks in heated buildings. There are from 4 to 6 generations of the insect per year.

LESSER GRAIN BORER



Lesser grain borer

Distribution

In warmer countries, it is carried into the temperate zones in goods, where it can only survive in warm warehouses.

Damage

Mainly attacks wheat, rye, corn, rice and millet. Badly infested wheat takes on a honey-like odor. Also attacks whole kernels as a primary pest. Both larvae and beetles bore into grains; irregularly-shaped boreholes are made and the flour produced by boring appears on the surface. Also attacked are beans, lentils, chick-peas, dried potatoes, tapioca and herbs. It is most common in wheat and one of the most destructive wheat insects. It is also known as the Australian Wheat Weevil.

Description

Adult

It is a beetle of 2-3 mm length, slim, cylindrical in body.

They are brown to black in color.

The large head is bent under the thorax, and the rear end of the body is blunt. The hood-shaped, rounded neck shield extends beyond the head; the spots on the shield gradually become smaller towards the rear.

The antennae has a large three-segmented senate club.

It can fly well in warm climates.

Eggs

They are elongate and pear shaped.

A female lays 300-500 eggs inside berries.

Development is only possible above 73^{0} F.

Larvae

They hatch inside the berry.

They are white, similar to grubs, and have brown head capsules.

They have hairs on the head.

Pupae

The white pupal stage is passed inside the kernel of grain.

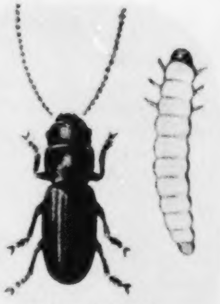
The complete life cycle varies from 28 days in warm climates to 110 days in northern cooler regions.

FLAT GRAIN BEETLE

Description

Adult

They are about 1/16 of an inch in length, flattened and oblong.



Flat grain beetle

The color is red to brown.

The antennae are two-thirds as long as the body.

It is often found with the rice weevil, as the adults cannot survive in whole grains, but feeds only on broken or otherwise damaged grain.

Eggs

Eggs are laid in ground grain materials.

They are very small and white.

Larvae

The larvae usually eat only the germ of while grains.

They also feed on dead insects.

When the larvae are full grown they form cocoons of a gelatinous material to which grain particles adhere.

Pupae

They transform to the pupal stage on the larval cocoons.

Later emerge as adults.

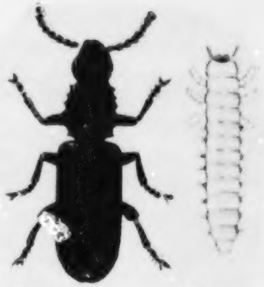
The life span of the flat grain beetle is from five to nine weeks.

SAWTOOTHED GRAIN BEETLE

Importance and Type of Injury

The sawtoothed grain beetle is one of the most common of beetles found infesting stored grains and other food products. Breeding of this insect is continuous in warm weather and where infestations are present. All life stages will be observed with both adults and larvae feeding.

Infested material will show many slender, much-flattened, small, dark-red beetles hurrying over the surface of the food. Its flattened shape enables this species to work into packages of food that are apparently tightly sealed. Feeding consists of scarring and roughening of the surface of the food. Its attack upon stored seeds usually follows that of other insects, since it is not able to attack sound seeds.



Saw-toothed grain beetle

Food

As with the confused flour beetle, this insect feeds on a great variety of products including practically all grains and grain products, dried fruits, breakfast foods, nuts, seeds, yeast, sugar, candy, tobacco, snuff, dried meats, and, in fact, almost all plant products used for human food.

Distribution

It is found throughout the world.

Description

Adult

The adult beetle is slender, flat and about 1/10 of an inch long, being one of the smallest of the grain insect pests.

It is red-brown in color.

They almost never fly.

The thorax bears six sawtoothed projections on each side.

In unheated buildings only the adult stage winters.

They have been kept alive for over 3 years.

Eggs

Female beetles lay 50-300 eggs by dropping them loosely in food material or by tucking them in a grain crevice.

The very small white eggs hatch in from three to five days.

Larvae

The larvae crawl about actively, feeding at random.

In warm weather they become full grown in about two weeks.

They are brown-headed, elongate, white six-legged grubs with abdoments tapering to the tip.

They become full-grown in 2-10 weeks when they are about 1/8 inch in length.

When full grown the larvae construct cocoon-like coverings by joining together food fragments with a sticky secretion.

Pupae

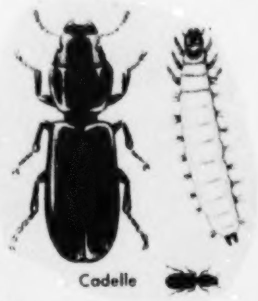
They remain in the pupal stage for 6-21 days.

They emerge as adult beetles.

There are from four to six generations annually throughout most of the United States. It is possible, under favorable conditions, for the entire life cycle to be passed in from 24 to 30 days.

CADELLE

Importance and Type of Injury



This insect is very common and is quite often found feeding on flour or meal as well as grain. Both the larvae and adults destroy grain and grain products. They have the destructive habit of going from one grain to another, eating out the germ.

Both the larvae and the adults can live for a long time without food. They may remain hidden in cracks and crevices of storage bins for a long time after grain is removed. When new grain is placed in the bin it soon becomes infested.

This insect is sometimes very important as a pest of stored grains, but it is also, to some extent, a feeder upon other insects. When abundant, however, it becomes seriously destructive in grain bins. It also causes damage in flour mills by cutting holes in flour sacks, silk bolting cloth, and other silk cloth used in the machinery and it eats holes in cartons of packaged foods.

Food

This insect is a general feeder on stored grains and seeds. It usually attacks the embryo, eating out only the softer parts of the grain. While the adults will often kill and feed upon other insects with which they come in contact, their general habits are not those of predaceous insects.

Description

Adult

Adult beetles are about 3/8 of an inch long, next to the meal worm, the largest of the insects attacking stored grain.

The color is shiny black.

They are oblong and flattened. The head and prothorax are distinctly separated from the rest of the body, to which it is attached by a rather loose, prominent joint.

Many of the adults live for a year, some even up to two years.

Both adults and larvae may survive over winter.

Females are capable of laying up to 1000 eggs per beetle in their lifetime.

Females commonly live for a year.

Eggs

The eggs are white and laid in masses of 10 to 60 in or near food materials. They prefer in cracks, under flaps of cartons, or in some protected situation.

Over 1,300 eggs have been secured from a single female.

They hatch in about one week in warm weather.

Larvae

The larvae are fleshy white with a black head.

They have two dark horny projections at the posterior end.

They have black spots in the three thoracic segments, just behind the head.

When full grown the larvae is about 3/4 of an inch in length.

The larvae frequently bore into timbers in wooden grain storage bins.

Under favorable conditions the larvae stage may last 70-90 days, otherwise it may require 7-14 months. They have been kept alive for 3 1/2 years.

Pupae

When fully grown the larvae pupate and shortly thereafter emerge as adult beetles.

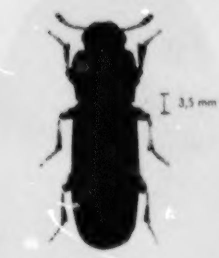
It requires about two and one-half months to complete the life span from egg to adult in warm weather.

CONFUSED & RED FLOUR BEETLES

These two species of stored grain pests are very closely related and will be described together.

Importance and Type of Injury

These insects most commonly occur in situations where grain products are stored. They are one of the most annoying pests in retail grocery stores and warehouses and extremely serious in flour mills. Infested material will show many elongate reddish-brown beetles, about 1/7 inch long, crawling over the material when it is disturbed, and brownish-white somewhat flattened six-legged larvae feeding on the inside of the grain kernels and crawling over the infested seeds. They are generally known among millers as "bran bugs".

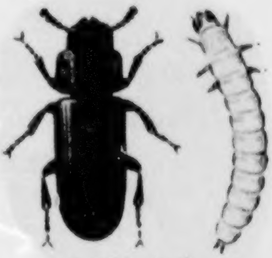


Tribolium confusum J. du V.

Confused flour beetle

Food

These insects feed on a great variety of products, including all kinds of grains, flours, starchy materials, beans, peas, baking powder, ginger, dried plant roots, dried fruits, insect collections, nuts, chocolate, drugs, snuff, cayenee pepper, and many other foods.



Red flour beetle

Distribution

The confused flour beetle was first noted in this country in 1893. Both species occur throughout the world, but the confused flour beetle is most abundant in the northern part of the United States, while the red flour beetle is not commonly found north of the forth first parallel. It may survive moderately cold winters in unheated buildings.

Description

Adults

The beetles are about 1/7 of an inch in length, flattened and oval shaped.

The head and upper parts of the thorax are densely covered with minute punctures.

The winged covers are ridged length-wise and puncture marks are between the ridges.

The average life of the beetle is about one year, but may live from three to four years.

About the only way to distinguish between the two species is to examine the antennae.

a. The segments of the antennae of the confused flour beetle increase in size gradually from the base to the tip.

b. The last few segments of the red flour beetle are much larger.

Eggs

Each female lays an average of 400 eggs, or as many as 1,000 eggs.

The eggs are small, white and laid loosely in flour or other meal material where the adults are living and feeding.

The eggs are covered with a sticky material and will stick to a box, sack or other container. Fresh material placed in them is quickly contaminated.

Eggs hatch in from five to twelve days.

Larvae

Larvae are small, worm-like, slender and wiry in appearance.

Fully grown larvae are about 3/16 of an inch in length.

They are white tinged with yellow.

The larvae feed on flour, grain dust, and the broken surfaces of grain particles.

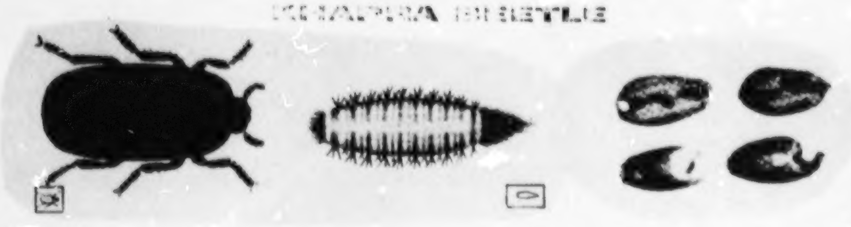
They become full-grown in 1 to 4 months, depending upon temperatures and kind of food.

Pupae

Larvae change to pupae and the pupae is without a case for 1 to 2 weeks.

The color at first is white, later yellow, and then brown.

The complete generation takes about 3 to 4 months when the temperatures is high. Under Kansas conditions 4 or 5 generations occur annually in heated store houses or mills. All stages of the insect may be found at any time of the year in such buildings.



KHAPRA BEETLE

Importance and Type of Injury

This is one of the worst stored-products pests in the world, preferring dried vegetable products but also attacking animal products. The larvae feed on grain having moisture contents as low as 2 per cent, tolerate temperatures to 111° F., and can live for as long as 3 years without food. They congregate in cracks and crevices and are very difficult to remove by ordinary sanitation.

Food

Wheat, barley, rice, oats, rye, corn, and many other seeds and grains and grain products, and such materials as dried blood, dried milk, fishmeal, hay or straw and flour and cereal products. The material which is attacked is reduced to a powdery mass. The larvae do the damage.

Distribution

This insect, which is a native of India, was first found in California in 1953, although it had apparently been present since 1946. It spread into Arizona and New Mexico and is now under federal quarantine, and an eradication program is being carried out.

Description

Adult

Small, brownish-black beetle, oval in shape, about 1/8 in. long. The female is larger than the male and lighter in color. The whole surface of the body and elytra is covered with fine hairs, giving the body a velvety appearance, but as these hairs are rubbed off in the process of movement, the adult becomes shiny. Females lay an average of about 90 white oval eggs. Adults do not feed and seldom fly.

Eggs

A little under 1/64 in. long, narrowly cylindrical, rounded at one end, pointed at the other end. Color varies from translucent white to reddish or yellow-brown. They hatch in from 3 to 14 days.

Larvae

Mature is 1/4 in. long. Hairs are yellowish-brown. Larvae has a reddish-brown appearance. Development varies from 19 to 190 days.

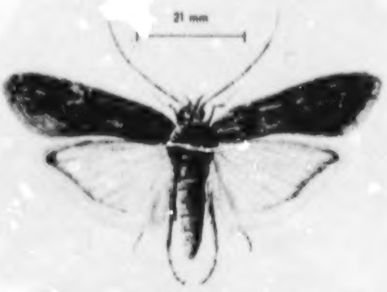
Pupae

Lighter brown than larvae. About 1/4 in. long. This stage lasts from 4 to 17 days. The length of all stages is determined by the temperature. The higher the temperature the faster the development. It may have from one to 5 generations per year. The life cycle requires 220 days at 70° F. and 26 days at 95° F.

MEDITERRANEAN FLOUR MOTH

Importance and Type of Injury

The Mediterranean flour moth was at one time the most troublesome insect occurring in flour mills in this country. However, modern fumigation methods have reduced its importance. Where this insect is present, masses of flour in chutes and elevators will be found webbed together and containing small pinkish-white caterpillars. The chutes may become entirely clogged and the machinery stopped by these webbed masses of flour. Small gray moths will also be noted flying about the infested buildings.



***Ephestia kuehniella* (Zell.)**

Mediterranean flour moth

Food

Flour is the favorite food of the insect, but it will attack also the whole grain of wheat, bran, breakfast foods, corn and other grains and pollen in beehives.

Distribution

The insect was first reported in North America in 1889 when it was found in Canada. It has now spread throughout the United States and Canada and probably throughout most of the world.

Description

Adult

It is a pale-gray color and is from 1/4 to 1/2 inch long. The head and tail are slightly raised when it is resting, this being very characteristic. The wings are marked with two zigzag lines of black which are not prominent.

Eggs

They are laid in accumulations of flour or other foods, in cracks about buildings, or on the cloth in spouts or bolters in mills. They hatch in from 3 to 6 days, depending on the temperature.

Larvae

After hatching the caterpillars immediately begin spinning silken threads which form into little tubes in which they live and feed. It is this web-spinning that causes the greatest amount of damage by the insect. When they are full grown they are about 3/5 of an inch long, a general whitish to pinkish color, and have three lengths of crockets in a circle on the prolegs.

Pupae

They pupate in silken cocoons for 8 to 12 days. Under conditions encountered in mills, the entire cycle usually takes from 9 to 10 weeks.

OCCUPATIONAL EXPERIENCE TRAINING PLAN
for
GENERAL FARM SUPPLY AND ELEVATOR EMPLOYEE

Page 1 of 5

Student Trainee

Training Station

Instructor-Supervisor

The student trainee will perform the following activities to the extent that business policy, interest, student progress, and time permit.

Competencies	Evaluation					Comments
	1	2	3	4	5	
FIRST AID						
Knows emergency telephone numbers						
Uses and knows location of proper first aid equipment						
Takes cardiopulmonary resuscitation training						
PREVENTION OF FIRE AND DUST EXPLOSIONS						
Maintains proper housekeeping						
Uses according to policy the electric arc and oxyacetylene welders						
Prevents excessive friction created by belts and bearings						
Prevents electrical sparks						
Avoids jogging of plugged elevator leg						
Removes scrap metal from cleaning magnet						
SAFETY PROCEDURES WITH TRUCK HOIST AND MANLIFT						
Inspects cables and cable clamps						
Inspects brakes, clutches, and gear boxes						
Operates and uses controls						
Demonstrates rules of safe operation						
PERSONAL SAFETY						
Maintains clean work areas						
Climbs ladders properly						
Maintains hard hat areas						
Avoids electrical shocks						
Prepares for various climatic conditions						
Demonstrates procedures in an emergency situation						
Knows safety regulations (OSHA, EPA, FDA)						

1 - Has not performed
2 - Has observed
3 - Has performed with supervision
4 - Has performed satisfactorily without supervision
5 - Has ability to instruct others

GENERAL FARM SUPPLY AND ELEVATOR EMPLOYEE

Page 2 of 5

Competencies	Evaluation					Comments
	1	2	3	4	5	
CLERICAL						
Prepares scale tickets						
Completes sales tickets						
Prepares bills of lading						
ANIMAL SCIENCE						
Formulates feeds according to instructions using proper milling equipment						
Identifies common feeds and feeding ingredients						
Selects proper form (pelleted, rolled, ground) in which feeds should be prepared						
PLANT SCIENCE						
Demonstrates timely identification of various types of grain damage (odors, insects)						
Identifies materials that might contaminate grain						
Identifies sources of grain contamination and takes corrective action						
Treats grain properly and safely for insect control						
Gathers field data for soil test sheet						
Interprets a computerized soil test report						
Recommends a fertility planning program						
Formulates fertilizer to specification						
Formulates herbicide-pesticide-fertilizer mixtures						
FERTILIZER PLANT FACILITY AND EQUIPMENT						
Demonstrates maintenance of the following plant equipment: Belts and motors						
Bearings						
Mixers						
Pumps and meters						
Hoses						
Valves						
Gauges (sight and pressure)						
Scales						
Blenders						
Augers and conveyors						
Payloaders						
Storage areas						
Spreaders						

1 - Has not performed
2 - Has observed
3 - Has performed with supervision
4 - Has performed satisfactorily without supervision
5 - Has ability to instruct others

GENERAL FARM SUPPLY AND ELEVATOR EMPLOYEE

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Competencies	Evaluation					Comments
	1	2	3	4	5	
Demonstrates proper operation of the following:						
Fertilizer blend mixers						
Fertilizer conveyors						
Fertilizer legs						
Liquid pumps and meters						
Fertilizer spreaders						
Maintains and/or operates the following NH_3 equipment, trailers, and fertilizer spreaders:						
Wheel bearings						
Fifth wheel pins and chassis						
Pressure relief valves						
Shutoff valves						
Hoses						
Water bags						
Decals, paint, and SMV signs						
NH_3 flow meters						
Applicator hoses						
Nozzles and spray rates						
Circulating pumps						
Chain and belt drives						
AGRICULTURAL MECHANICS						
Demonstrates knowledge and use of scales						
Weighs grain as it arrives at scales						
Operates seed-treating and seed-cleaning equipment						
Operates and adjusts equipment used in a grain, feed, seed, and fertilizer facility						
Secures feed and grain sample properly						
Demonstrates effective uses of sampling equipment, moisture testers, screens, and grain dividers						
Operates and reads devices for detecting heating of grain in storage						
Secures a representative sample of grain from a truck or car						
Calibrates spreading equipment to apply specific amounts of fertilizer or chemicals						
WAREHOUSE MANAGEMENT						
Maintains integrity of grains						
Maintains integrity of fertilizers						
Maintains integrity of drugs (drug in-out chart)						

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Competencies	Evaluation					Comments
	1	2	3	4	5	
Maintains rodent control						
Demonstrates efficient use of loading and unloading equipment						
Maintains proper inventory levels						
Uses aeration, drying, and turning techniques to preserve grain quality						
Loads cars or trucks with grain for shipment						
MILL OPERATION						
Maintains ingredient identification						
Operates mill equipment properly						
Handles and conditions ingredients properly						
Processes feed according to registration requirements						
Handles physically bagged product properly						
Loads product out according to regulatory requirements						
AGRICULTURAL BUSINESS MANAGEMENT						
Understands state and federal laws regarding grain, feed, seed, and fertilizer business						
Understands the legal responsibilities of a business serving the public						
PROPER TECHNIQUES FOR FARM DELIVERIES						
Delivers according to office instructions						
Delivers at the proper time						
Sets equipment for proper spread						
Marks beginning and end of spread distinctly						
Consults customer for special instructions						
Keeps customer informed of progress of spreading						
Closes all closed gates						
Is helpful to customer						
Is cheerful and courteous						
DESIRABLE PERSONAL QUALITIES AND QUALIFICATIONS						
Demonstrates the ability to get along with others						
Demonstrates the ability to work on own						
Demonstrates a willingness to work						
Demonstrates the ability to project a desirable image for the firm						
Demonstrates personal integrity as an employee of the firm						

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GENERAL FARM SUPPLY AND ELEVATOR EMPLOYEE Page 5 of 5

Competencies	Evaluation					Comments
	1	2	3	4	5	
Budgets time						
Maintains a satisfactory attendance record						
Demonstrates a desirable job attitude about the organization when working with fellow employees, potential customers, and customers						
Demonstrates a willingness to learn or take supervision						
Demonstrates the ability to follow directions of supervisor						
Demonstrates an acceptable personal appearance and personal hygiene						
Maintains proper customer relations						
Demonstrates the ability to accept responsibility						

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5 - Has ability to instruct others